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FROM THE MAKERS OF **BBC FOCUS MAGAZINE**

CUREUNEA'S

VIRTUAL REALITY

THE COMPLETE GUIDE

2016 - the year when virtual becomes reality



THE BEST
VR GADGETS
HEADSETS, CAMERAS,
APPS & MORE!



DISCOVER

Apple's plans to challenge the Oculus Rift

Why augmented reality is going to change life as we know it

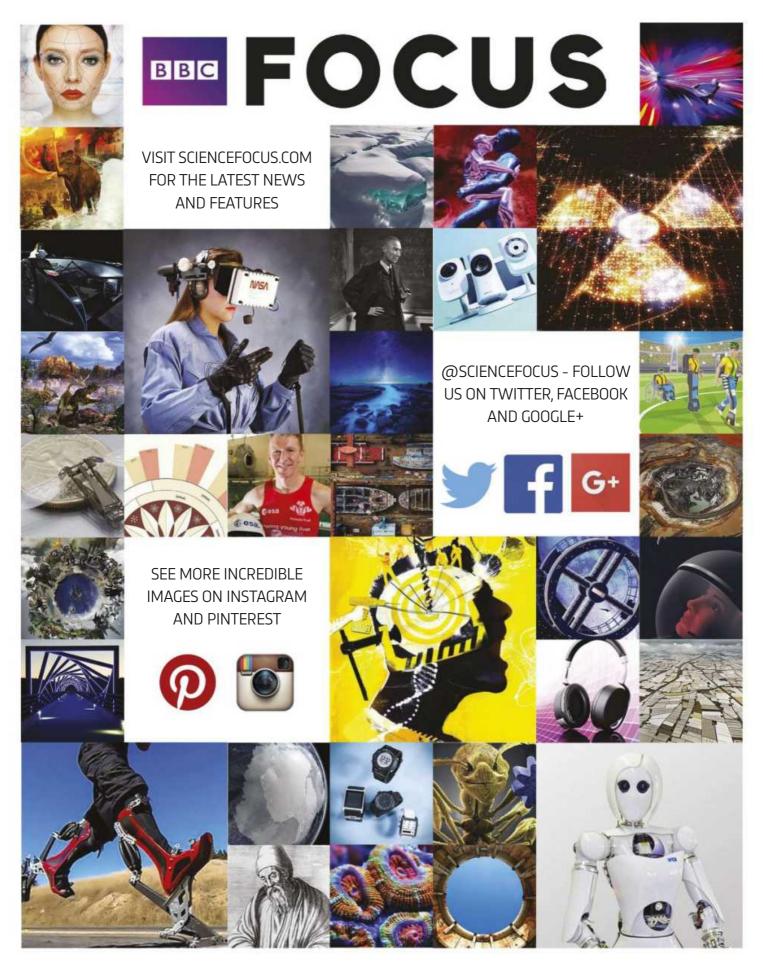
How VR is transforming cars, medicine and education



DOES VR MAKE YOU SICK?

CAN YOU WEAR GLASSES WITH VR?

WILL VR WORK WITH RASPBERRY PI?



THE ULTIMATE MAGAZINE FOR CURIOUS MINDS

'ER: OCULUS THIS PAGE GETTY X2

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While every attempt has been made to ensure that the content of Virtual Reality. The Complete Guide was as accurate as possible at time of press, we acknowledge that some information contained herein may have since become out of date. Also, the content of certain sections is occasionally subject to interpretation; in these cases, we have favoured the most respected source.

WELCOME



I don't know about you but my youthful days were filled first with Lego, then an Acorn Electron before progressing to the Commodore Amiga and, ultimately, the pub. Californian Palmer Luckey, on the other hand, still only 23, grew up watching sci-fi films, reading sci-fi novels and tinkering with computers in his parents' garage. What did we have in common? We both grew up wanting to escape. But while myself and

many others sought a getaway in our imaginations or the bottom of a pint glass, Luckey wanted to immerse himself and others in a virtual world. The result of his tinkering cost Facebook founder Mark Zuckerberg \$2-billion in 2014. Now the Oculus Rift is ready to hit the mass market, signalling the new dawn of virtual reality.

We check out Palmer's handiwork in our buyer's guide, starting on page 34, but don't worry if your bank account's not quite as Luckey. Our writer covers the full price range and respective feature lists, starting from the smartphone Google Cardboard up to HTC's £700 Vive, which allows for augmented-reality integration.

With CG and real-life apps flooding the market (more on pages 52-55), this is a gamechanger for gaming. But VR is so much more than that, as you'll discover in our 'VR: The Present' section (page 32 onwards). A taster of current uses includes training elite sportsmen and improving education, while the future could see augmented reality eclipse VR in sales with the joint VR/AR market expected to hit \$150-billion by 2020. But that's for the future. Take pride in the fact that you were the first invitees to the virtual party...

James Witts, Editor

IN YOUR VR GUIDE



VR: THE PAST

Would you believe that the seeds for virtual reality were sown back in 1838? Or that Palmer Luckey constructed the prototypes for his billion-dollar Oculus Rift in his parents' garage? Read on to find out more... → p8



VR: THE PRESENT

VR isn't the sole preserve of the rich or science geeks – it's a brave new world that's open to all. Inform your purchase with our buyer's guide covering units from £0 to £700. Also discover VR's practical uses. → p32



VR: THE FUTURE

Find out why augmented reality might be bigger than VR; how the newsroom and citizen journalism will change forever; Apple's plans to dominate the virtual world; plus the social side of virtual reality. → p90



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The history of VR

We chart the evolution of virtual reality, from featuring in early 20th-century fiction to the Aspen Movie Map, which pre-dated Google Street view by nearly 30 years...

Immersed in film

VR dominated the recent SXSW Film Festival but producers have attempted 'unique' ways to add a multi-sensory element for over 50 years. Cue Scent of Mystery, House of Wax...

The gamechanger

Meet the 23-year-old Californian who utilised his parents' garage to create the unit that had Mark Zuckerberg forking out a cool \$2-billion. Welcome to the world of Palmer Luckey

London's most cutting-edge company?

Shoreditch-based Inition are at the forefront of VR and AR technology. We visited their studio and discovered a technological Narnia

Future success

Sport provides the perfect platform to maximise VR, whether it's in a training setting or as a spectator. Check out how athletes will soon race higher, faster and stronger













VR theme parks

Discover how illusionist Derren
Brown has been applying his
mystical talents to Thorpe Park's
new virtual-reality ride, plus a VR
rollercoaster comes to Alton Towers

Beating trauma

Virtual reality is more than just entertainment. Find out how it's increasingly being used to treat soldiers suffering from PTSD

Revolutionising industry

From teaching students about the pyramids to viewing mansions worth over £15-million, discover how virtual reality is already making an impact on the professional sphere

Kate Russell's Q&A

Reporter, regular on BBC technology show Click and virtual-reality authority Kate Russell answers common VR-related questions. You'll be an expert in no time...

Tomorrow's world

VR is going to be big – but will augmented reality be even bigger? Discover what happens when hologram technology meets haptics

Apple's VR dream team

The technological giants have been quiet when it comes to VR. But as our reporter reveals, they've been sweeping up the sector's most dynamic companies and greatest brains...

Journalism's next frontier

Newsrooms and citizen journalism will be transformed by VR and AR. It begs the question: are we about to enter a brave new world of empathy?

Recognising the risks

With any new technology there are certain unknowns. We chart the potential dangers... and how to overcome them

Virtually social

VR doesn't have to be a solitary experience. We introduce the online platforms, technical cafes and multi-player games that will make virtual reality more social



VR: THE PAST

Things have come a long way since the humble View-Master. It's time to chart the evolution of virtual reality

DISCOVER

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THE GAMECHANGER

PROFILE OF OCULUS FOUNDER PALMER LUCKEY

The View-Master launched in 1939. It was originally intended as an alternative to the scenic postcard







The Oculus Rift didn't appear from nowhere. Step back in time to see how art fused with technology to create entire worlds...

Words: lan Evenden



s is often the case when recounting the story of technology that's sprung from Silicon Valley, the history of virtual reality throws up a lot of the same names and places. And when you're dealing with

such high-tech ideas, sometimes the truth can be blurred as much by military interest as it can be by late nights and too much caffeine.

What we do know is that virtual reality, or something very close to it, was first mentioned in a 1936 short story by Stanley G Weinbaum. 'Pygmalion's Spectacles', published in the June 1936 edition of *Wonder Stories* magazine, features 'a device vaguely reminiscent of a gas mask' that has 'goggles and a rubber mouthpiece' and which plays back holographic recordings held in a strange liquid, bringing sights, sounds, smells and even a sense of touch to its wearer.

Cinematographer Morton Heilig then took up the baton, writing in the 1950s of cinema technology that could speak to all our senses. He would make his vision a reality in 1962 thanks to the Sensorama, a mechanical cabinet that the viewer sat in which was capable of displaying stereoscopic 3D movies with stereo sound. It could also tilt its occupant and blow air into his or her face to simulate wind or convey smells.



ABOVE: Morton L Heilig inventor of the Sensorama circa 1968

RIGHT: Viewers sat in the Sensorama booth and experienced sights, sounds and smells



Only five short films were made for it, as Heilig was unable to secure financial backing, but he would also patent a head-mounted display device.

FLIGHT SIMULATORS

The struggle for funding is another thread that runs through this story. If your idea needs equipment that may cost many tens of thousands of dollars, where can you find that sort of money? Thomas A Furness III, now a professor at the University of Washington and often called the 'grandfather of virtual reality', solved this problem in 1966 when he was commissioned by the US Air Force to build the first flight simulator.

The military's interest in VR as a technology for training continues to this day, as Matthieu Poyade, a Research Fellow in 3D Programming at the Digital Design Studio of The Glasgow School of Art, explains: "In VR you can train people for tasks that would be too complex to train in the real world. Flight simulators are usually very expensive, but if you've got a much more affordable device – like a haptic device for example – that can allow you to train particular abilities or specific skills.

"In the US there's been quite a long relationship [between military equipment manufacturers and VR companies]," Poyade continues. "In the UK and in Europe the relationship is slightly less than 10 years old, but it's being built. It's comfortable for the military companies because they can save a huge amount of money by using VR rather than mocking up a specific tank or boat or aircraft carrier. With VR they can assess several situations. For instance, they can carry out

"In 1968 Dr Ivan Sutherland of MIT created the Sword of Damacles... the forerunner of today's VR systems"



ABOVE: Heilig even created his own 3D motion-picture camera for capturing short films

human factor assessments, like the accessibility of specific pieces of equipment, taking into consideration the physical characteristics of users."

THE SWORD OF DAMACLES

Away from the military contracts, progress was being made in other labs, too, and in 1968 Dr Ivan Sutherland of MIT (Massachusetts Institute of Technology) created the Sword of Damocles, a ceiling-mounted mechanical arm that held a head-mounted display using two CRT (Cathode Ray Tube) screens that communicated simple wireframe graphics to the wearer. The arm tracked their head movements as they looked around, but was difficult to use as the viewer's head was clamped into its helmet. Its 'unique' appearance is behind its name, but it's recognisable as the forerunner of the VR systems we see today.

Another ancestor of today's technology was developed in 1978, again at MIT, with funding from military technology agency DARPA (Defense Advanced Research Projects Agency). The Aspen Movie Map was a little like Google Street View, with footage of the streets of Aspen, Colorado, recorded on Laserdiscs, linked to a database of the city's layout, and played back using a touchscreen interface that could bring up information about



EVOLUTION OF VIRTUAL REALITY

The rise, fall and rise of a new world

1838

Charles Wheatstone shows that the brain can construct a 3D image from two 2D ones with his Stereoscope photo viewer.

1936

Pygmalion's Spectacles published, a short story that predicts the form and function of VR helmets.

1929

The Link Trainer is invented to train pilots. It uses pumps, valves and bellows to simulate instrument flying in bad weather or at night.

French dramatist Antonin Artaud describes theatre as "la réalité virtuelle" - the first published use of the term.



1938

The View-Master stereoscopic photo viewer is released, bringing 3D photos of famous monuments to the public.



1960

Morton Heilig patents the Telesphere Mask, a head-mounted 3D display for showing films but without head-tracking.



1939



1965

Ivan Sutherland

describes an 'Ultimate

Display' in a paper. It can

simulate reality to the

point the wearer can't tell the difference.

1966 Thomas A Furness III builds the first flight simulator for the US Air Force.



1968

Ivan Sutherland and Bob Sproull create the Sword of Damocles headtracking system at Harvard University



1961

Philco Corporation's Headsight uses a screen for each eye and a head-tracking system linked to cameras for remote viewing of dangerous military situations.



Artist Myron Krueger develops Glowflow, a computer-controlled environment that responds to the people in it.



The 'Atari Shock' wipes billions off the value of American videogame companies. VR research is one of its victims.



1978

The Aspen Movie Map is filmed and produced at MIT, paving the way for services such as Google's Street View.



Virtuality's 1000 Series arcade machines are released. Powered by an Amiga 3000 computer, they offer only nine games.



Feature film The Lawnmower Man, based in part on the work of Jaron Lanier, brings the concepts of VR to a wider audience



Nintendo's Virtual Boy is launched to worldwide apathy thanks to its primitive graphics, high cost and uncomfortable user position.



Palmer Luckey founds Oculus VR, selling it to Facebook in 2014 and launching its first product, the Rift VR helmet, in 2016.



1987

Star Trek: The Next ${\it Generation}\ introduces \, the$ Holodeck, which uses transporter, forcefield and food replicator technology to create solid virtual worlds.





buildings that were touched, such as restaurant menus or historical details. It even used a vehicle with cameras on top that, unlike Google's version, drove slowly in the middle of the road and towed a bicycle wheel behind it to help measure distance and trigger the cameras.

"It was the first time we used the term 'virtual environment'," says Professor Scott Fisher, now an Associate Dean of Research at the University of Southern California, who worked on the map project at MIT. "We built a special camera rig to go on top of a truck that we had, then drove it up and down every street and around every corner in Aspen. Our rig had four cameras — pointing left, right, front and back — and we tried lots of different lens systems to achieve a wide angle. We'd stitch the footage together on the discs, and Street View is very much a derivative of that early work.

"We didn't have it running in a head-mount, but we did do it stereoscopically," Fisher continues. "We had a room, one whole wall of which was a back-projected video display, and you could point at the screen. So we projected the Aspen footage onto that while sitting in an instrumented Eames chair, and you could actually drive around Aspen while you were sitting in that room. We also filmed on the ski slopes with helmet-mounted cameras by renting cranes to shoot from high above. We did handheld stuff, too, where we'd go into all the restaurants and some commercial buildings on the main street in Aspen. Basically, we tried to build as comprehensive a visual database as possible."

The Department of Defense saw the map as a way for its soldiers to quickly familiarise themselves with new areas they may be operating in. Although driving slowly through a warzone

LEFT: The Aspen Movie Map acted as a precursor to Google's Street View. It was created all the way back in 1978

PHOTOS: MIT ARCHITECTURE MACHINE GROUP, GETTY

BELOW: A US soldier being trained using a virtual-reality 3D shootout army facility over 20 years ago



THE VIRTUAL BOY

Nintendo's ill-fated attempt at gaining a foothold in the immersive 3D gaming market

The Virtual Boy, released in 1995 across Japan and the US but never in Europe, was a 3D games console that originated in stereoscopic screen technology from Massachusetts-based Reflection Technology Inc. Turned down by Sega, the single-colour display found its way into the hands of Gunpei Yokoi, head of an R&A team at Nintendo and the father of the Game & Watch and Game Boy handheld games consoles.

Having experimented with colour screens, the original red and black display was chosen for the

production model as it was not only cheaper, but provided a greater sense of 3D depth. Although marketed as a form of VR, the Virtual Boy's head-tracking capabilities were removed during development due to fears over inducing motion sickness in players, and it was designed to be used sitting at a table – though a promised harness for use while standing up never materialised, and nor did a link cable to allow multiplayer 3D gaming.

After four years in development, the unit that made it to market was

heavy and produced a constant mechanical whirring sound. At \$180 it was expensive for the time and received only 14 games in the US, with a further five available in Japan, during its short life.

Discontinued in 1996, the Virtual Boy became Nintendo's second greatest commercial failure after the 64DD console. With only 1.26-million units shipped worldwide, today it has some value as a collector's item, but its wireframe graphics look primitive and some users have complained of headaches and dizziness.





ABOVE: Dr Jaron Lanier is a virtual-reality pioneer who now works for Microsoft Research

while dragging a bicycle wheel might still put some lives at risk, it would be quicker and cheaper than building replicas of operational areas, a technique pioneered by Israeli commandos for hostage rescue operations.

THE SAYRE GLOVES

At around the same time, scientists from the Electronic Visualization Laboratory at the University of Illinois in Chicago were creating the first wired glove. Known as the Sayre glove, it was

created by Daniel J Sandin and Thomas Defanti from an idea by Richard Sayre, and used light emitters and photocells in the fingers. As the fingers flexed, the amount of light hitting the photocell varied, allowing finger movement to be translated into electrical signals.

In 1982, Thomas G
Zimmerman would file a patent
for such an optical flex sensor,
and would go on to work with
Dr Jaron Lanier – the man
credited with coining the term
'virtual reality' – to add
ultrasonic and magnetic handposition tracking technology to
a glove. This led to what would

become the Nintendo Power Glove, sold alongside a small number – two – of NES games in 1987.

"Virtual reality originally meant an extended version of virtual worlds," says Lanier, who these days is to be found working for Microsoft Research as well as writing books and music. "Ivan [Sutherland] had talked about the virtual world that you would see through a headset like that. He didn't make up that term; it actually comes from an art historian called Susanne Langer, who was using it as a way to think about modernist painting. To me, what virtual reality originally meant was moving beyond the headset experience to include some other elements, which would include your own body being present, so to have an avatar where you could pick up things, and also where there could be multiple people, where it could be social."

THE CYBERGLOVE

Datagloves continue to be a part of the VR world today, and in 1990 Virtual Technologies Inc released the CyberGlove. It's a product that exists to this day in the form of the CyberGlove III, which is mounted with up to 22 sensors and can detect movements of less than one degree.

1982 also saw the videogame world become interested in VR. Atari opened a VR research lab that year, and the company would employ Zimmerman, Fisher, Lanier and many other VR pioneers. But the videogame crash of 1983, known as the 'Atari Shock', saw 97% wiped off revenues

"1983's
videogame
crash saw 97%
wiped off
gaming
revenues and
Atari's VR
lab closed"



Q&A The innovator

not very practical. But it was

Research] had a haptic glove

that they called a Dataglove.

with sensors, which you also

see today. At the time the suit

They also had a bodysuit

cost between \$45,000 and

\$90,000, and the whole VR

gear cost close to \$250,000.

Nothing was mainstream at

the time. The VR software I

use every day now, Unity, is

very advanced. They [VPL]

Paris-based artist Nicole Stenger is credited with creating the first totally immersive movie, Angels, between 1989 and 1992

How did you first experience virtual reality?

In 1989 I went to Boston, where there was a SIGGRAPH [Special Interest Group on Graphics and Interactive Techniques exhibition. I had a recommendation from MIT for an animation which I was working on at the time. While I was at SIGGRAPH I met Jaron Lanier, who was quite a colourful character. We were both waiting in line and he was very nice to me, letting me go first to buy my ticket. I attended his talk and realised that this was real, that [VR] was really happening and that you could use it. I decided to turn my 3D animation into a VR movie, which became Angels.

Describe the equipment that you used.

It had a similar helmet to what you'd use today, except it was heavier and Technologies was worth over \$50,000."

What are you doing now?

I just ordered the Oculus Rift. specifically because Angels is being re-done completely inside the new equipment that should be available this vear. After that, my last movie, The Wish, which was launched in 2015, will also be ported into Oculus. That should be available

BELOW: Renowned artist Nicole Stenger using virtual-reality equipment developed by Jaron Lanier

"The VR software I use every day now is free; at the time the software was worth over \$50,000"





BELOW: A Polhemus tracking system also played a key role in the VPL VR experience. It's seen here displayed in a Tokyo showroom



from gaming in North America. Atari was sold and split up, its VR lab closed, but many of its researchers were able to continue their work, leading to an explosion of new companies.

For Lanier this was VPL Research, which had its first HQ in a corner of his San Francisco home. Zimmerman joined him, and the company produced datagloves and a head-mounted display, becoming one of the first in the world to sell such items. LSD enthusiast and early transhuman thinker Timothy Leary, searching for legal means to explore consciousness after his release from jail, became associated with the company through his friend Brenda Laurel, a VPL employee who had also worked for Atari.

"We sold the first general-purpose simulator," explains Lanier. "I made the first surgical simulator collaborating with a doctor at Stanford Medical; the first vehicle

prototyping simulator; the first architecture simulators. We made the first versions of all those things, and we sold the kits that allowed a lot of other people to make a lot of their prototypes."

NASA PROJECT

Fisher, meanwhile, was aiming for the stars. In 1985, he founded the Virtual Environment Workstation Project at NASA's Ames Research Center in Mountain View, California. The lab's purpose was to produce a virtual reality system for astronauts, so they could control robots outside a space station instead of taking part in risky EVAs. "It usually took almost four hours to do all the prebreathing and the prep to do an EVA for a satellite

ABOVE: Lanier worked at VPL Research, where they produced datagloves and a head-mounted display

BELOW: An employee at NASA using the Virtual Interactive Environment Workstation (VIEW) back in the 1990s inspection or a space-station inspection," says Fisher. "And it's obviously dangerous to do that. So one of the big applications of what we were doing was to be able to control robots in teleprescence mode from inside the space station.

"The head-mounted display had super-wide-angle optics – about a 180° field of view – so we built a camera system that had matching optics. The servos on it were matched to specs that we found for fighter pilots in combat who are moving their heads pretty fast to figure out where a threat is coming from.

"We really over-specced the robots we built, but that was the configuration we passed on to Lockheed and Grumman who were designing, and eventually building, the systems for use outside the space station.

"We did a lot of work with instrumented gloves to actually control the remote robot arms, trying to figure out how we map human hand gestures

onto the dexterous end effector that some of the contractors were building,"
Fisher continues. "At one point we even instrumented the gloves with tactile feedback so the astronauts would have a sense of what they were touching. We started looking at temperature feedback, too, although that's super complicated because the

nerves that respond to temperature respond at a different rate than for haptic feedback." At Ames, Fisher would meet Mark Bolas,

> now Associate Professor of Interactive Media at the University of Southern California. Bolas would go on to found VR hardware outfit Fakespace in 1988.

GAMING DEVELOPMENTS

Then, in 1990 Dr Jonathan Waldern, who'd been



THE OMNIDIRECTIONAL TREADMILL

Who'd have thought that running on the spot could be so much fun?

The omnidirectional treadmill ties into the idea of 'immersion' – the perception of being physically present in a non-physical world. As you move your feet, the virtual world moves around you, as displayed through your head-mounted display. The treadmill is designed to keep you in its centre, either through a mechanical solution that moves the surface beneath you no matter which way you're facing or an array of spheres your feet can slide across. Users are often tethered in place or surrounded by a safety barrier so they don't launch themselves onto the floor.

A Kickstarter campaign by Virtuix was successful, raising money for the development of the Omni, a device to help you move naturally and freely in virtual worlds, but the concept of the omnidirectional treadmill goes back much further than that...

Back in the 1990s, American tech author Ben Delaney charted the brief rise of virtual reality in his book Sex, Drugs and Tessellation: the Truth About Virtual Reality. Delaney recalls that the omni treadmill in the image below never received a retail name because it didn't reach the stage of mass production. "But I do know that the protagonist on the treadmill is David Carmein in his laboratory back in 1997," says Delaney. "There were also shots taken in various military facilities, including the Naval Postgraduate School in Monterey, California."

The original omni might not have taken off but the idea didn't die. The US Army currently uses omnidirectional treadmills in association with CAVE Graphics – essentially a room with screens making up every wall. As a trainee marches on the spot, the world moves around them and training scenarios can be played out.

Further applications include gaming, an avenue Virtuix is tapping into, and in the movie industry, recording actors moving on the spot in front of a green screen so that moving footage can be spliced in behind them.



LEFT: Virtuix has revived the omnidirectional treadmill with gamers its primary audience

BELOW: Virtuix users will require a sizeable abode to accommodate its treadmill





OTOS: VIRTUIX, OM

BELOW: A woman absorbed in the Atari Jaguar VR booth at the 1995 Electronic Entertainment Expo



researching VR since 1985 at Loughborough University with the support of IBM's labs in Hursley, Hampshire, demonstrated his Virtuality gaming system as part of the Computer Graphics 90 exhibition at London's Alexandra Palace. That's when the world of videogaming started to take another look at VR.

Virtuality comprised a stereoscopic visor, handheld joysticks and network capability to enable multiplayer gaming. Datagloves and 3D tracking systems were also available, and British Telecom bought two units for its research labs, to explore the possibilities of telepresence communication systems. There were talks about bringing Virtuality to Atari's Jaguar games console, launched in 1993, but they fell through.

Japanese gaming company Sega announced its VR system for coin-op arcade games and its Mega Drive console in 1991, although the home version would eventually be cancelled. Sega was rumoured to be working on something similar for its 1994 Saturn console but, if the headset existed, it was never announced. Fierce competitors Nintendo would get in on the act with its Virtual Boy (see *The Virtual Boy* box on page 16) in 1995, but the commercial failures of such systems led to a retreat from virtual reality by gaming companies. Virtuality would keep

going until 1997, but a lack of demand for the expensive machines led to the company's breakup.

VR SLUMP

"I left the scene in around 1992," explains Lanier, "and for most of that time it wasn't well known. There was a burst of publicity toward the end of the 80s and the start of the 90s – I was in the same as Palmer Luckey, where I was on the cover of a lot of mags – and then it kind of went away again."

The years after 1997 represent a slump for VR. Google would launch Street View in 2007, and Palmer Luckey would design the first prototype of the Oculus Rift in 2010, rekindling public interest and bringing us to where we are in 2016 and the promise of a defining year in the evolution of VR.

"When I started to work in VR – around the year 2000 – we had head-mounted displays that weren't too different to what you see today," says Poyade. "They were a bit bulkier because of the cables, but

the difference was the price. They were several thousand pounds for one device.

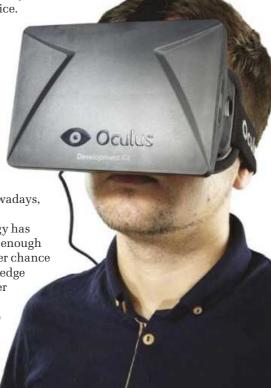
Today it's lighter and cheaper and more accessible for customers. During the last 10 years, the software we use to develop VR content has improved. When I started, it was hardcore coding, and now it's more like a graphical language with a very tiny amount of coding required. Users with less expertise in programming

and coding are more able, nowadays, to develop VR content."

It's only now that technology has become cheap and accessible enough that virtual reality has another chance to shine. Built on the cutting-edge thinking and ingenuity of over 60 years, this blend of technology and art is about to hit the mainstream, and peering into virtual worlds could become as normal as watching TV.

lan Evenden is a freelance writer and editor, mainly covering science, gaming, technology and photography. ABOVE: Nintendo's Power Glove was only available for a year (1989-1990) but its legacy lives on in popular culture thanks to speed-metal band Powerglove

BELOW: The past 25 years has seen many VR false dawns, but that looks set to change in 2016 with units like the Oculus Rift









HOUSE OF WAX

Main actors Vincent Price, Carolyn Jones, Frank Lovejoy

Date of release 1953

Audience rating on Rotten Tomato 72%

Worldwide box office £17,072,551

PLOT Vincent Price plays Professor Henry Jarrod, a wax sculptor who runs a museum in New York. When a financial partner suggests that they burn the museum down to receive insurance money. Jarrod tries to stop him, only to be badly beaten in the burning museum. Escaping horribly disfigured, Jarrod builds a new museum that showcases crimes, including the murder of his former business partner...

VR INFLUENCE Back in the 1950s, with television halving cinema attendance, Tinseltown launched its inaugural three-dimensional ventures, with Warner Bros' House of Wax the first 3D flick in colour. Unlike Scent of Mystery (see right), the House of Wax is a superior film in its own right, with the 3D elements being used sparingly but effectively. Employing two separate 35mm film prints for the left-eye and right-eye images on separate but interlocked projectors, the 3D elements included a wax museum fire, can-can girls and, most famously, a paddleball-wielding pitchman. Ironically the director, André de Toth, was blind in one eye and unable to experience the 3D effects.

"Back in the 1950s, with television halving cinema attendance, Tinseltown launched its inaugural 3D ventures with Warner Bros' House of Wax"

SCENT OF MYSTERY

Main actors Denholm Elliott, Peter Lorre, **Beverly Bentley**

Date of release 1960

Audience rating on Rotten Tomato N/A

Worldwide box office N/A

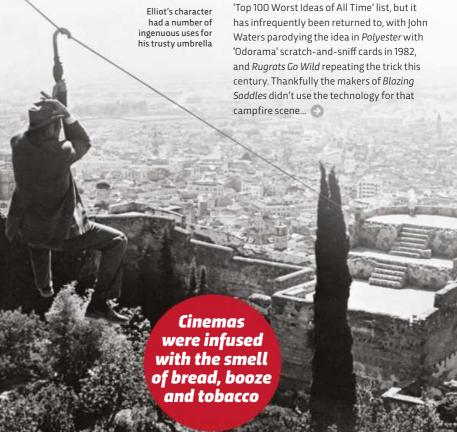
PLOT The first film to be choreographed with immersive smells in the production process is a sub-Hitchcockian murder conspiracy that finds an elusive young American tourist (played by Beverly Bentley) being targeted by a vengeful conspiracy. Denholm Elliott (Marcus in Indiana Jones), German film legend Peter Lorre and Paul Lukas are amongst the goodies and villains running around Spain in pursuit.

VR INFLUENCE The 'AromaRama' of documentary Behind the Great Wall may, just, have been the first film to deliver smells to the audience, but the 'Smell-O-Vision' of Scent of Mystery was the first film to be made with odour projection in mind during production. The process saw smells piped through plastic tubing into audiences at specially equipped cinemas, with fresh bread, booze and tobacco just a trio of odours to reach the nostrils of the punters. The



audience reaction was mixed, the pun-filled critical consensus worse and the film stank, sorry, sank without trace at the box office. 'Smell-O-Vision' was once included in Time's





TRON

Main actors Jeff Bridges, Bruce Boxleitner, David Warner

Date of release 1982

Audience rating on Rotten Tomato 69%

Worldwide box office £19,309,685

PLOT Computer game developer Kevin Flynn (Jeff Bridges) is digitally broken down into a 3D graphical world of computers called the Grid. Flynn is forced to participate in gladiatorial games where his only chance of escaping is by joining forces with a security programme named Tron. Together they duel with the artificial intelligence Master Control Program that holds them captive.

VR INFLUENCE Director Steven Lisberger's groundbreaking Tron experienced a lukewarm commercial reaction on release, but it's since entered the annals of cult classic, influencing the likes of Toy Story,





a famous Simpsons' episode and French group Daft Punk, who went on to produce the score for the sequel, 2010's Tron: Legacy. A rare film about, not based on, computer games (a medium that's long fired our VR

After the watershed:

imaginations), Tron's narrative is one of the first plots driven by the concept of virtual reality, with the 'human sucked into a computer' theme that continued in War Games and Spy Kids 3D: Game Over.

THE LAWNMOWER MAN

Main actors Jeff Fahey, Pierce Brosnan, Jenny Wright

Date of release 1992

Audience rating on **Rotten Tomato 31%**

Worldwide box office £23,031,816

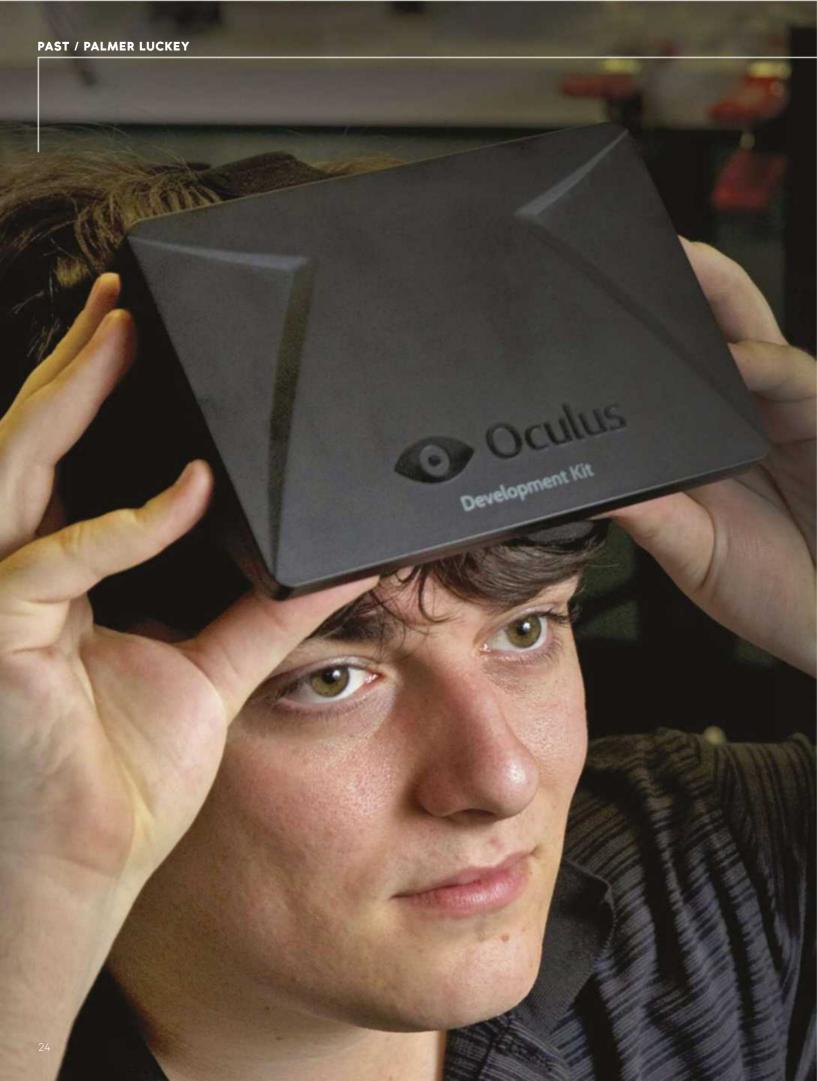
PLOT Scientist Dr Lawrence Angelo (future Bond Pierce Brosnan) performs experiments involving intelligence-enhancing drugs and virtual reality on Jobe, a simple-minded gardener played by Jeff Fahey. After an accident shuts the programme down, Jobe develops telekinetic powers and enters the mainframe computer, abandoning his body to become a wholly virtual being.

VR INFLUENCE VR magazines started to be published around this time, Sega released its VR headset for arcade games in 1991 and Hollywood was using digital effects with stunning degree in the Terminator 2. The Lawnmower Man mirrors the public fascination with this emerging tech by featuring computeraugmented headsets, Jobe's VR mind experiments and warnings about a VR future. It also contains what's believed to be the first computer-generated love scene in film history.

"The film mirrors the public fascination with this emerging tech by featuring computeraugmented headsets"







THE GAMECHANGER

WHY IS 2016 BEING SEEN AS THE YEAR OF VIRTUAL REALITY? IT'S ALL DOWN TO THE OCULUS RIFT AND ITS TINKERING FOUNDER

WORDS: NIGE TASSELL



t's a story that makes even the biggest-ever investment on *Dragons' Den* look like loose change chucked into a charity bucket. In March 2014, Facebook founder Mark Zuckerberg coughed up a cool \$2-billion to buy Oculus VR, a fledgling company operating in the vanguard of virtual-reality technology. It looked like the deal of the century for Oculus' founder, a young twenty-something called Palmer Luckey. After all, as potentially revolutionary as his VR system – the Oculus Rift – was, it hadn't been produced yet, let alone sold a single unit.

Two years on, the Rift – a headset that resembles a cross between a black plastic brick and a chunky pair of ski goggles – is now available to the masses. Connecting to your PC via a lightweight 10-foot cable and with assistance from a separate positional sensor, it offers a VR experience more immersive, more realistic, than any previously presented. One of its chief assets is its smoothness. Where past systems often resulted in

"At 23, he is the hottest property in Silicon Valley, estimated by Forbes magazine to be worth \$500m"

feelings of nausea and dizziness, the Rift's software is able to render video at a stomach-settling 75 frames per second. Small wonder then that the reaction – from fan-boy geeks at trade shows to the single most powerful geek of them all – has been consistent and unwavering. Three letters, one syllable. 'Wow!'

Palmer Luckey is succeeding where hundreds of engineers, not to mention billions of dollars, have singularly failed. Many have tried but crashed and burned. For them, the notion of bringing ultrarealistic virtual reality to the masses remains an impossible dream. But the way the Rift's inventor modestly calls it, his was a tale of perspiration over

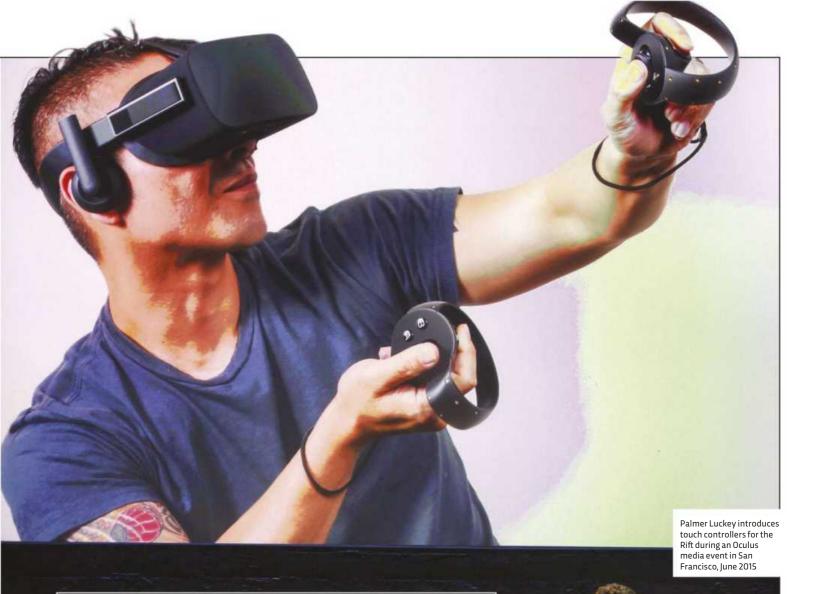
inspiration when it came to reigniting the VR world. "It wasn't that I was the best at what I was doing," he confessed to the *Telegraph*. "I was just one of the only ones that persevered. Nobody had managed to pull this off. Then 'Bam!'"

SILICON'S HOTTEST PROPERTY

The perseverance shown by Luckey during his teenage years has certainly bore fruit. At the age of 23, he is the hottest property in Silicon Valley, estimated by Forbes magazine to be worth at least \$500m, a value even greater than that of Zuckerberg when he was the same age. But Luckey's path to this point didn't follow in the Facebook founder's footsteps; their trajectories traced very different arcs. While Zuckerberg's initial achievements were made as he breathed in the rarefied Ivy League air, Luckey's formative years were spent learning his craft and honing his ideas in somewhat more prosaic surroundings: his parents' garage.

Born and raised in Long Beach, California, Luckey was the eldest of four children all home-schooled by their mother. The flexibility offered by such an arrangement (not to mention the weekly hours saved by not travelling to school) meant that the young Palmer had a fair amount of time on his hands. And, when he wasn't watching sci-fi films or reading sci-fi novels, he would be out in the garage — tinkering, tinkering, tinkering. While his siblings were soaking up the California sun, Palmer stayed inside, surrounded by wires, cables, consoles, screens and computers.

At first, he spent his time taking apart video-game consoles, modifying them, improving them. At the same time, he developed a sideline in buying broken iPhones, reconditioning them and re-selling for a handsome profit. These proceeds – believed to be around \$30,000, no small amount for a teenager from a family of modest means – were re-invested in hardware. Not just any old hardware, though. For Palmer Luckey's obsession with video games didn't lie with becoming the best player around. He wanted to create the best possible gaming experience, an environment that was thoroughly immersive, one that provided the





GET LUCKEY

The beginner's guide to the saviour of virtual reality

Name Palmer Freeman Luckey Age 23

Appearance Over-enthusiastic but sartorially relaxed video-store assistant. Famous for Inventing the most realistic virtual-reality system yet seen – the Oculus Rift. And for his enduring love of flip-flops.

Virtual reality? Never going to happen, is it? Try telling that to Facebook's Mark Zuckerberg. In 2014, he paid \$2bn for Luckey's company Oculus VR.
Blimey, so he's worth a few bob, then?

Blimey, so he's worth a few bob, then? Forbes magazine reckons Luckey's stake in the company would have given him a personal fortune somewhere in the region of \$500m. Not bad for one so young.

One of Zuckerberg's well-connected Least likely to say, "D Harvard pals, is he? Not at all. Aside from a brogues in a size 10?"

couple of semesters studying journalism at CalTech, he was home-schooled by his mum in Long Beach, California. His dad was a car salesman. I suppose you're going to tell me he invented the Rift in his bedroom or something? Not quite. He spent years working on it as a teenager in his parents' garage, before moving his operations to a room in a local motel. Amazing story. Who'd play him in the film of his life? Anything could be possible in the world of virtual reality, so perhaps a Brat-Pack-era Charlie Sheen - if he took a little less care of his hair. Most likely to say, "We've revitalised an entire segment of dreams. That's super-cool."

Least likely to say, "Do you have these brogues in a size 10?"



complete escapism offered by his favourite movies and favourite books.

Although proud of the multi-screen gaming system he developed ("a beautiful six-monitor set-up"), Luckey knew that a headset would be the only way to get that complete immersion. He trawled online auctions for VR hardware that had long since passed its sell-by date, whether developed by the government, military or gaming companies who'd long since abandoned their VR dreams. Luckey scored some bargains, too; perhaps his car-salesman father had passed on something in the genes. In one auction, Luckey Jr managed to bag a \$97,000 headset for less than \$100.

For the next couple of years he refined his own headset but it would be the sixth prototype that began to make waves. Luckey had been aided in its development by the goodwill of the online community, those similarly curious about the potential of VR. John Carmack was one of those forum members — but he was no ordinary forum member. He was gaming royalty, the lead programmer on such celebrated games as *Doom* and *Quake*. Luckey sent Carmack one of his prototypes. Two months later, Carmack demo'ed it at the Electronic Entertainment Expo (aka E3) in Los Angeles, where he declared it to be "probably the best VR demo the world has ever seen". Luckey was still only 19.

KICKSTARTED INTO ACTION

The word was out. Luckey had initially intended to offer the Rift as a not-for-profit DIY kit on Kickstarter, but now interested parties were taking notice. One gaming entrepreneur, Brendan Iribe, offered to finance a Kickstarter campaign. A no-strings-attached cheque for \$5,000 allowed Luckey to move his operations from his parents' garage to a nearby motel where he and a friend turned a room into both living quarters and laboratory, plugs jammed into every socket.

Initially, Luckey and Iribe had set a \$500,000 Kickstarter target, but the teenager developed cold feet and sliced the target in half. He needn't have worried. The campaign streaked past the quarter-of-a-million mark within a couple of hours. That particular day, Luckey was demo-ing his creation at the QuakeCon gaming expo in Dallas. What he saw on the ground confirmed his wildest dreams. "We had a line that was over two hours long the whole weekend," he later told Forbes magazine. "That's when I realised, 'Oh man, this is gonna be huge. Ordinary people are interested in virtual reality, not just us crazy sci-fi nerds'."

And venture capitalists were proving to be interested, too, with the phenomenal success of the Kickstarter campaign – it raised \$2.4 million in a month – difficult to ignore. As an experienced gaming entrepreneur (he was all of 32 years of age, after all), Iribe became Oculus VR's CEO, while Luckey took the less formal title of 'founder'. It was a role that suited him well. For a man once described as "engagingly goofy", he would be the figurehead, the charming spokesman in the Atari T-shirt and flip-flops. He'd provide the enthusiasm, the inspiration and the indefatigable optimism of youth.

Two further rounds of investment followed: a \$16m deal in June 2013, followed by a \$75m injection six



OCULUS RIFT: THE NAME GAME

Just where did that unique moniker come from?

Conventional business wisdom dictates that any entrepreneur launching his or her new product on a possibly sceptical marketplace first needs to come up with a name for their creation that's short, sharp and, most crucially, highly memorable. Picking a name that's not only drawn from Latin but that sounds like an enemy spacecraft from Star Wars or a James Bond villain doesn't necessarily fit the bill. But Palmer Luckey isn't fussed about fitting the bill. He doesn't really do conventional.

"Why the name 'Oculus'?" he mused in an online posting in the early days of the company's evolution. "Because it's the Latin word for 'eye'. Someone used the word in a meeting several months ago. I thought it was a nifty word and was better than the alternative – 'StepN2theGAME'." As for 'Rift', Luckey later revealed that the word referenced "a rift between the real world and the virtual world" that the headset created, before adding a 21st-century caveat: "I have to admit that it is pretty silly."

months later by technology investors Andreessen Horowitz. Again, the mix of Luckey's charm and tech savvyness were a strong attraction. "When we first met Palmer," explained Chris Dixon, a partner at the new investors, "we saw that he not only believed in the VR dream, but also understood how to put together all the key underlying technologies to make it a reality."

But then, in early 2014, along came Mark Elliot Zuckerberg. Initially, Zuckerberg was concerned that Oculus saw their creation's primary, if not sole, use

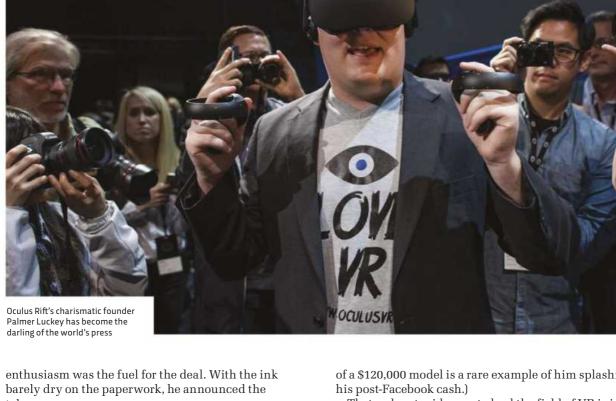
"The Kickstarter campaign reached its \$250,000 target within a couple of

being to improve the leisure experience of gamers.

Nonetheless – and fired by the belief that immersive
3D headsets could revolutionise business, education, medicine and beyond – he got his hands on a Rift headset to try it for himself.

That Zuckerberg was sufficiently impressed with what he experienced was borne out by the \$2-billion deal he thrashed out with Iribe.

Although Facebook had recently stumped up \$19-billion for WhatsApp, the amount being paid for Oculus VR – a company still without a product on the market – was extraordinary. But Zuckerberg's



takeover.

GRADUAL ATTRACTION

With the commitment and the cash of the most technologically influential individual on the planet, the fundamental question surrounding VR's application to everyday life has changed. It's not longer a case of if but when. VR is now high on the agendas of Sony, Microsoft and Google. In fact, when, a few months after the Facebook deal was signed, Google rushed out its budgetend VR project Google Cardboard - where a smartphone is inserted into a cardboard headset - its critics offered up an alternative name: 'Oculus Thrift'.

To what extent the Rift will set the gaming world alight on its launch remains to be seen. "It'll ramp up slowly," Zuckerberg cautioned Vanity Fair. "The first smartphones ... I don't know if they sold a million units in the first year. But it kind of doubles and triples each year, and you end up with something that tens of millions of people have."

Zuckerberg is playing the long game. Similarly, in terms of the technological possibilities, Luckey feels that he and the Rift are still in the foothills of VR. "This is the Model T," he explained to Smithsonian magazine. "We eventually want to be where the Tesla is. What we have now is something that's affordable, that's good enough for people, and that will be able to sustain the growth that's needed to get to the Tesla." (He's a particular fan of Tesla cars. His purchase

of a \$120,000 model is a rare example of him splashing

That a planet-wide race to lead the field of VR is in progress is down to the resolve and resilience of this young man from Long Beach. Palmer Luckey might now be dropping the odd corporate phrase like "sustain the growth", and he might have an inordinate amount of money in the bank, but he essentially remains the mop-haired geek in the garage.

With his on-going adherence to slacker attire, the cash registers of Gucci and Armani remain unopened by his dollars. Similarly, he eschews fancy restaurants to indulge his lifelong love of fast food. For a considerable time after those various multi-million dollar deals, he chose to share a house with half-adozen pals called The Commune.

With his time split between the Oculus and Facebook offices these days, Luckey has less time to tinker with the hardware, to iron out the technical niggles. Not that he believes his baby has been taken out of his hands; it's more that someone else is now doing the dirty work of changing the diapers.

At only 23 years of age, Luckey remains grounded. His boyish face might have graced the covers of some of the world's leading magazines, but his humility is tangible and he's reluctant to be forever seen as Mr Oculus. "I'm telling you," he insisted to the Telegraph, "in a few years I won't be the face of the company like Steve Jobs was with Apple. I'll go back to obscurity. This isn't about me. It's about something much, much bigger. Bigger perhaps than any of us." •



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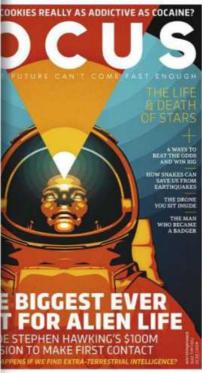
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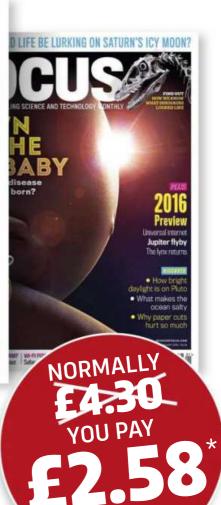
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VR HEADSETS AT A GLANCE

		PRICE	WEB ADDRESS	IOS	ANDROID	PC	FIELD OF VIEW	PAGE
	GOOGLE CARDBOARD	FROM £00.00	www.google.com/cardboard	•	•	×	90°	35
	FREEFLYVR	£55.00	WWW.FREEFLYVR.COM	•	•	×	120°	35
	MERGE VR	£71.00	WWW.MERGEVR.COM	•	•	×	85°	36
8	SAMSUNG GEAR VR	£71.00	WWW.OCULUS.COM/GEAR-VR	×	•	×	96°	36-37
H Mino	HOMIDO	£48.00	www.homido.com	•	•	×	100°	37
	VISUS	£107.00	WWW.VISUSVR.COM	×	×	•	110°	41
	IMPRESSION PI	£TBA	WWW.IMPRESSIONPI.COM	•	•	×	90°	41
	CMOAR	£93.00- £104.00	WWW.CMOAR.COM	•	•	•	105°	42
	SULON CORTEX	£TBA	WWW.SULON.COM	×	×	•	100°	42-43
B DSVF	RAZER OSVR	£215.00	WWW.OSVR.ORG	×	×	•	100°	43
	OCULUS RIFT	£432.00	WWW.OCULUS.COM	×	×	•	100°	45
5	PLAYSTATION VR	£350.00	WWW.PLAYSTATION.COM	×	×	×	100°	45
	STAR VR	£TBA	WWW.STARVR.COM	×	×	•	210°	46
	HTC VIVE	£689.00	WWW.HTCVIVE.COM	×	×	•	110°	46-47
6	AVEGANT GLYPH	£504.00	WWW.AVEGANT.COM	•	•	•	45°	47

£0-£89.99

AFFORDABLE VR UNITS

You can sample the delights of virtual reality for under £90.00...

WORDS: DAVID BODDINGTON

Virtual reality is no longer the preserve of developers and the super rich. Now anyone can give VR a go, just by downloading a free app onto your smartphone and getting your hands on a cheap (or even free) VR unit. These entry-level headsets broadly consist of a case that houses your phone and a couple of lenses, which bend the light emanating from the phone screen, giving the illusion of a wrap-around virtual world.

Most modern smartphones also contain their own accelerometers and motion-tracking sensors, which allow basic VR apps to roughly track the position of your head relative to the virtual landscape, so make sure yours is up to the task before investing in a

headset. At this price point, you can also expect a comfortable, adjustable headset that's appreciated if you're planning on spending significant chunks of time in VR.

For all VR units it's vital to consider the field of view they offer. The eye can perceive around 200° horizontally, and in order for VR to truly work a headset needs to support at least 60°. Generally, though, the greater the field of view possible, the deeper the immersion.

Make sure you also use headphones instead of your phone's speaker, as this will also make a huge difference to how 'real' the world feels. Right, onto the entry-level units...

JARGON BUSTER

Interpupillary distance (IPD)

The distance between the centre of the pupils of your eyes, or the centre of lenses in a headset.

Field of view

The breadth of the world that's visible at any given time.

360 video

Real world video shot using special cameras, allowing you to change your playback viewpoint in real time.



GOOGLE CARDBOARD

WWW GOOGLE COM/CARDBOARD

Google Cardboard is the gateway drug to the hedonistic world of virtual reality. Made, quite literally, of cardboard, the digital giant's entrylevel VR unit design is open source, so you can either download the blueprints and make your own (see page 38 for more details), or you can buy one of the many unofficial viewers

available online. These units allow you to slot in your smartphone, hold it up to your face, and experience basic VR and 360° video via a multitude of free and paid-for apps. Two fixed lenses bend the light from the two halves of the phone screen to create the 90° field of view effect, and a magnet on the side of the unit



can control your phone as a switch. It's great fun for 10 minutes and making your grandma a little bit seasick, but definitely not a lasting virtual-reality solution.

"LENSES BEND THE LIGHT FROM THE TWO HALVES OF THE PHONE TO CREATE THE 90° FIFI D OF VIFW"

£55.00

FREEFLY VR

WWW.FREEFLYVR.COM

Freefly VR is a step up from Cardboard. First and foremost, the addition of adjustable headstraps means you can enjoy a hands-free experience and, combined with fauxleather face padding (though some users say this becomes uncomfortably hot), it'll allow you to enjoy longer gaming sessions in comfort. It also has a safe, enclosed smartphone compartment - so you don't need to worry about your

phone slipping out – and will house phones between 135mm and 165mm in length. The Freefly is compatible with Cardboard apps and, as such, simply looking around can control most games. The unit is also bundled with the wireless Glide controller, which allows you to control deeper gaming experiences. It comes with a hard carry case, so you can easily show off your newly discovered

digital worlds to your mates, and the lenses provide an impressive 120° field of vision, which compares favourably with the moreexpensive Samsung Gear VR at 96°.

"THE ADDITION OF ADJUSTABLE HEAD-STRAPS MEANS YOU CAN ENJOY A HANDS-FREE EXPERIENCE"



PRESENT / BUYER'S GUIDE: AFFORDABLE VR UNITS



MERGE VR

 ${\sf WWW.MERGEVR.COM}$

The Merge VR is all about fun, comfort and durability. Constructed from soft, flexible foam, the main body of the unit is designed to withstand a life on the road in your backpack, stuffed in alongside all manner of other gadgets and guff. Unlike its competitors in this price bracket, it boasts two input buttons housed on top of the device, which interface with your smartphone to provide additional control input on

certain apps and games. The IPD is adjustable, as are the head straps, and it has ventilation holes to prevent the distraction of screen fogging. The design even has a little extra space between the nose bridge and the lenses, so you should be able to wear glasses underneath if required. It displays an adequate field of view of 85°, and should work with most iOS and Android devices of less than two years old.

"THE MERGE DISPLAYS AN ADEQUATE FIELD OF VIEW OF 85°, AND SHOULD WORK WITH MOST IOS AND ANDROID DEVICES OF LESS THAN TWO YEARS OLD" £71.00

SAMSUNG GEAR VR

WWW.OCULUS.COM/GEAR-VR

The Gear VR is only compatible with recent Samsung Galaxy devices but, as such, it has a more engineered feel than other models here. It has on-board hardware in the shape of accelerometer, gyroscope and proximitybased sensors, which automatically link with your Galaxy smartphone via the micro USB dock built into the housing. This takes the performance strain off your phone, allowing Gear VR to run games and apps with lower latency and higher performance, resulting in a more immersive experience. It also has a touch pad and back button on the side of the unit for simple navigation, along with volume controls and a focus adjuster, and it displays a 96° field of view.

KEY TECHNOLOGY AT UNDER £90

How to maximise the minimal features

Sound Audio experience is as important as the visual when enjoying smartphone-powered VR. VR is about tricking your brain into thinking you are really 'there'. That means aligning as many of the five senses as possible with the artificial world. Good-quality stereo headphones that block out other sounds and submerge you in a 360° auditory space are a must.

Light Make sure you spend time adjusting the straps and set-up of your unit so it fits snuggly to your face, and that no light is leaking in around the nose. As with Google Cardboard this may not be possible, so instead try using the unit only in the evening at home where light levels will be lower.

Head movement At the lower end of the headset market, you won't have much processing power to work with, so make sure you keep your head movements slow and smooth. Not only will this take the strain off your phone processor and make for less jarring visuals, but it'll also help reduce the risk of cybersickness. Avoid leaning from side to side, too, as most units will not be able to accurately reproduce this motion, leading to that queasy feeling in your stomach.



£48.00

HOMIDO

WWW.HOMIDO.COM

The Homido is another great entrylevel virtual-reality headset. The basic model comes with the essential adjustable headstraps, but this time with a dial, which ensures vou can achieve the perfect fit. You can alter the distance between the lenses and your eyes, and change the interpupillary distance (IPD), both of which can help reduce the risk of experiencing cybersickness and

help to produce a more immersive experience. Phones are securely clipped to the front of the device, and it can accommodate screen sizes between 89 x 49mm and 126 x 71mm. There's potentially good news if you wear glasses, too, because it comes bundled with lens cones adapted for short- and long-sighted users. The field of view afforded by the set-up also comes in at a solid 100°.



"YOU CAN ALTER THE DISTANCE BETWEEN THE LENSES AND YOUR EYES, AND CHANGE THE INTERPUPILLARY DISTANCE, BOTH OF WHICH REDUCE THE RISK OF CYBERSICKNESS"







If you're willing to spend a little more, then the world of VR opens up a whole new world of possibilities. In this price bracket you'll find cutting-edge features, with augmented as well as virtual reality making real headway. This is where consumers and homebrew enthusiasts alike are able to take advantage of unexplored corners of the virtual future.

You won't necessarily need a highspec smartphone for these units, as some are already equipped with their own screens, or can have screens bolted on for an additional fee. Likewise, some units will do all their processing on board, whereas others rely on PCs or hardware to do the heavy lifting.

If you're looking to invest, however, units like these are more of a gamble, as software platforms are varied and future support is by no means guaranteed. It's especially important to beware of high latency and low field of view, as these can ruin an otherwise promising VR experience. But choose wisely and you could get your hands on a top-tier VR for a fraction of the price, and enjoy being part of the leading group of early adopters of this new technology.

JARGON BUSTER

Screen Door Effect When zoomed in on a screen image, the lines between individual pixels become visible.

Latency The time between an action taking place and it being observed, or data being output by a computer and seen in the headset.

OLED screen A thin-film transistor backplane, which switches individual pixels on or off, and allows for higher resolutions and deeper blacks.

VISUS

WWW.VISUSVR.COM

The Visus brings PC gaming into the virtual-reality space at an amazingly low price point. Instead of having its own costly display, it takes advantage of your smartphone as a high resolution screen, and uses Nvidia's GameStream technology to send games wirelessly from your base PC. It also features a latency of around 27m/s and a field of view of around 110°.

It has its own built-in hardware, which sends the motion data back to the host PC for head tracking, but you can still use other controllers for aiming and direction input. You'll also need to take the fiscal hit on the Tridef 3D conversion software. which effectively sets up two cameras in whichever game you want to play, and automatically creates left and right eye viewpoints for



"THE VISUS BRINGS PC GAMING INTO THE VIRTUAL-REALITY SPACE AT AN AMAZINGLY LOW PRICE"

the headset, giving the perception of 3D. This is far from a simple plug-and-play virtual-reality experience but, nonetheless, very interesting for such a small outlay.

IMPRESSION PI

WWW.IMPRESSIONPI.COM

The Impression Pi has two front-facing cameras, which allow for real-world hand gesture tracking. This means you can control software simply by moving your hands around in front of you. A representation of vour hands is then projected into the virtual environment that you're viewing. The Impression Pi has also been developed with augmented reality in mind, again using the cameras to view the

real world and deliver a hologramaugmented version back to the user on the display screen. These cameras are also able to track your position within a room, and adapt virtual environments to fit your real-world space. It promises to be available either with or without a built-in screen, so if you want to keep costs down you can still use your smartphone. Kickstarter bundles began at \$250 but



final retail pricing is yet to be confirmed, though it should be under the £300 mark. Once the production model hits the market later this year, it's expected to have a field of view of 90°.

"ONCE THE PRODUCTION MODEL HITS THE MARKET, IT'S EXPECTED TO HAVE A FIELD OF VIEW OF 90°"



PRESENT / BUYER'S GUIDE: TOP-END VR UNITS



WWW CMOAR COM

The Cmoar features on-board hardware to assist with head tracking and, in turn, reduce latency and increase the performance potential of your smartphone. It can connect to your phone via micro USB or Bluetooth, and the 48mm lenses offer a field of view up to 105°. The smartphone housing has a gap for your phone's camera, and there's a button on the side of the headset that can activate it, switching you from VR into a real-world view without needing to

remove the headset. The top-tier \$269 Cmoar package also comes with double hand-motion controllers for gaming and navigation, and a 'home theatre' module, which you can swap in to give a narrower field of view, as well as reducing the screen door effect for watching movies. For another \$99 you can add a 1920 x 1080 HD screen, which you can connect to your PC via HDMI, bringing with it the potential for low-latency, high-quality gaming.

"THE TOP-TIER CMOAR PACKAGE COMES WITH DOUBLE HAND-MOTION CONTROLLERS FOR GAMING AND NAVIGATION" SULON CORTEX

WWW.SULON.COM

Merging virtual and augmented reality into one product is an attractive proposition, and although other headsets are attempting this to varying degrees, the Sulon Cortex is going after it in a big way. The Cortex is a fully untethered AVR unit that promises to transform any physical space into a Star Trek holodeck-like environment. It uses spatial scanning technology and two frontfacing cameras to create a 360° map of the space around you, which it constantly updates. This will lead to interesting AR gaming opportunities, though it has an HDMI input, too, which will allow you to hook up to a PC for a more traditional sitdown VR experience.

KEY TECHNOLOGY AT £90-£299

Essentials of low-latency augmented reality

High-quality, accurate, low-latency augmented reality, like featured in the Sulon Cortex, is no mean feat. Being tethered by wires or restricted to a space containing motion trackers doesn't limit the VR experience, but integrating true high-end AR means you need to be completely wireless, offering greater freedom.

The headset also needs to have a high processing capacity in order to quickly map and track your environment, and then render holograms over real-world object contours. Of course, it's vital that this happens with extremely low latency otherwise the illusion will swiftly shatter.

Along with robust head rotation and motion-tracking hardware, at least two cameras need to be mounted on the front of the headset to ensure accurate spatial perception and to aid with gesture control. And it's worth it as the ability to transform your real-world hands into the virtual environment dispenses the need for handheld controllers.

For this kind of technology to make a lasting impact in the entertainment space, however, headsets will need to be lighter – not an easy task when all the processing, screens, cameras, batteries and assorted other tech needs to be housed on board.



£215.00

RAZER OSVR

WWW.OSVR.ORG

OSVR stands for Open Source Virtual Reality, highlighting that this range is all about homebrew development. The idea behind the initiative is to open the doors of VR to everyone, and allow the wider industry to share successes and failures. OSVR offers its own software platform and different hardware 'hacker' kits. The £215 Hacker Dev kit 1.3 comes with a 5.5-inch OLED screen with a pixel density of 401ppi, so

you don't need a smartphone. It also has infrared sensors built into the faceplate, which provides positional information with 360° tracking, along with an integrated accelerometer, gyroscope and compass, and three USB connectors that allow other modules to be connected. You can even download all the product schematics, allowing the brave and technically minded to tinker and make



OSVR stands for Open Source Virtual Reality, highlighting that this range is all about homebrew development

further developments of their own. The OSVR has a 100° field of view. "IT HAS INFRARED SENSORS BUILT INTO THE FACEPLATE, WHICH PROVIDES 360° POSITIONAL INFORMATION"



TOP-END VR UNITS

Spend over £350 and you'll never want to return to planet Earth. Welcome to Oculus Rift, Sony...

WORDS: DAVID BODDINGTON

To enjoy the best that the world of VR has to offer, you're going to have to part with some serious cash, but for that outlay you'll enjoy some serious technology. All of the biggest players in the market are found in this price bracket, including the brand that's received huge media focus, the Oculus Rift. (For more on Oculus founder, Palmer Luckey, turn to page 26.)

Almost all the top-tier units hitting the shelves this year will require a high-end PC or a current generation console to work, and that's with good reason. They need significant processing power to deliver the highfidelity, resolution and frame rates, not to mention extremely low latency, to ensure the most immersive experience possible, so it's important to bear in mind existing kit you own.

Watch out for headset bundles, too, as only some will contain the extra peripherals you need to get the most out of the tech, such as external position trackers and dual hand controllers. Before flexing your PayPal account, it's also important to check on the latest game compatibility to make sure that your headset of choice will seamlessly work with your favourite titles.

JARGON BUSTER

Fiducial marker An object placed in an imaging system's field of view to act as a point of reference or scale.

6° of freedom The motion that can apply to a body in 3D space: forward/back, up/down, left/right, pitch, yaw and roll.

Refresh rate The number of individual images or frames displayed each second, measured in hertz (Hz).

Fresnal lenses Flat lenses made up of multiple concentric rings, which help to reduce image imperfections from spherical aberration.

£432.00

OCULUS RIFT

WWW.OCULUS.COM

When you think of virtual reality, one name virtually pirouettes before your eyes like a tornado. Oculus Rift's founder, Palmer Luckey, built the first prototype in his parents' garage in 2011, and since then it has come a very long way. Facebook bought Oculus in 2014 for \$2 billion, and now the first retail units are finally hitting the high street. The

headset itself is beautifully designed and comfortable to wear. It contains two 1080 x 1200 OLED panels that, together with the lenses, allow for a field of view over 100° and a refresh rate of 90Hz. The Constellation tracking system uses infrared LEDs mounted on the headset to track position, delivering the full 6° of freedom. which reduces the potential for

cybersickness and increases immersion.
The headset also has built-in headphones, and it ships with an Xbox One controller and an Oculus remote. In order to run the Rift, you'll

The Oculus Rift allows for a field of view over 100° and a refresh rate of 90Hz

The Constellation for a field of view over 100° and a refresh rate of 90Hz

The Oculus Rift allows for a field of view over 100° and a refresh rate of 90Hz

The Constellation for a field of view over 100° and a refresh rate of 90Hz

The Constellation for a field of view over 100° and a refresh rate of 90Hz

The Oculus Rift allows for a field of view over 100° and a refresh rate of 90Hz

The Oculus Rift allows for a field of view over 100° and a refresh rate of 90Hz

£350.00

PLAYSTATION VR

WWW.PLAYSTATION.COM

Originally codenamed 'Project Morpheus', the PlayStation VR unit works in conjunction with the PlayStation 4 console. The headset will contain a full-HD LCD 1920 ${
m x}$ 1080 display. Together with the lenses, the Playstation VR will convey a 100° field of view, and it houses a stereo headphone jack that will deliver a specially designed 360° audio experience. It can also produce a

beautifully smooth refresh rate of 120Hz. Positional light emitting diodes on the headset and Dual Shock 4 controller will provide the PlayStation Camera with spatial tracking data, so your exact movements can be reflected in-game. The PlayStation PS4 will also output a 2D image of gameplay onto your television screen, so that you can still have a shared gaming experience with friends. Games

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expected at launch in October include a new version of Battlezone (the original regarded as the first virtualreality arcade game) and gangster title The London Heist.

need a beast of a PC,

with at least i5-4590

CPU and GTX 970

GPU, or equivalent.

"GAMES EXPECTED AT LAUNCH INCLUDE A NEW VERSION OF BATTLEZONE AND THE LONDON HEIST"

6° OF FREEDOM. WHICH

INCREASES IMMERSION"



PRESENT / BUYER'S GUIDE: TOP-END VR UNITS



STARVR

WWW STARVR COM

Boasting the largest field of view currently available is the StarVR. The headset manages an impressive 210° by housing two separate 5.5-inch quad HD panels, with one angled for each eye, giving a total panoramic definition of 5120 x 1440 pixels and a 90Hz refresh rate. Together with highquality Fresnal lenses, this minimises the screen door effect, creating an incredibly immersive

experience. Although final release specs are yet to be announced, it currently uses a fiducial marker system, with barcodes on the headset and peripherals for highly accurate positional tracking. Owned by game developer Starbreeze (of Payday fame), the StarVR will run games built not only on third-party platforms, but also those developed with their own 'Valhalla' game engine.

"IT CURRENTLY USES A FIDUCIAL MARKER SYSTEM WITH BARCODES ON THE HEADSET AND PERIPHERALS FOR HIGHLY ACCURATE POSITIONAL TRACKING"

£689.00

HTC VIVE

WWW.HTCVIVE.COM

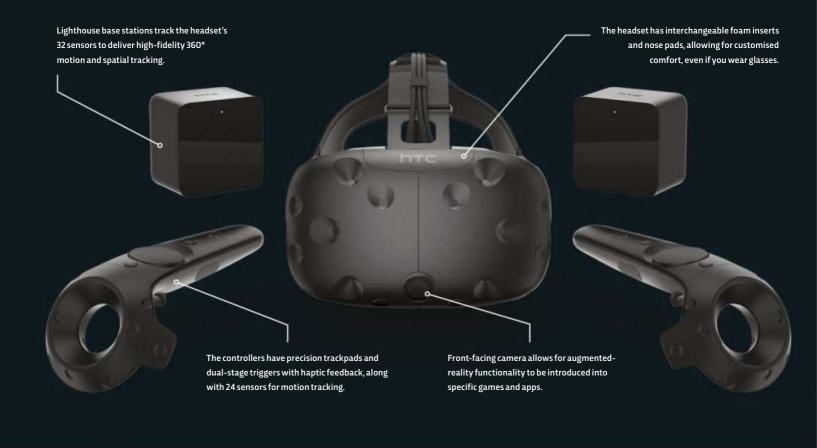
Powered by the almighty Valve's Steam VR, the HTC Vive is perhaps the most exciting headset currently available. At £689, though, it's a hefty outlay (not to mention the Goliath of a PC you'll need to make the most of it), but out of the box you get the headset, two wireless controllers with haptic feedback and room-scale motion tracking. The headset itself is comfortable and highly adjustable, contains 32 sensors for 360° motion tracking and has a front-facing camera to allow for AR integration. It displays at 2160 x 1200, has a refresh rate of 90Hz and achieves a field of view of 110°. Steam VR also promises to deliver the best in class gaming content, and HTC has partnerships in place with HBO, Lionsgate and Google with the potential to bring yet more amazing content to the platform.

KEY TECHNOLOGY AT £350-PLUS

Higher resolution means greater immersion

The screen resolution and supported refresh rate of headsets available at this price point can make a huge difference to your virtual experience. Aside from simply making everything in the virtual world smoother and appear more substantial, higher refresh rates tend to put a lot less strain on the user's eyes, while also reducing the likelihood of suffering from cybersickness. The PlayStation VR's potential display panel refresh rate of 120Hz blows the competition out of the water in this regard, although it remains to be seen how many games will be able to take full advantage of this.

The resolution afforded by the headset's screens will also make a big difference to the experience. Once the light emitted by the display panels has been bent and magnified by the lenses, the screen door effect can become both noticeable and genuinely distracting, so a higher resolution will inevitably have a positive impact on overall immersion. The StarVR's total 5120 x 1440 pixels across both eyes promises to bring this effect down to near zero, and combined with the 210° horizontal by 130° vertical field of view, it could well emerge as a new standard that other manufacturers will quickly have to match.



£504.00

AVEGANT GLYPH

WWW.AVEGANT.COM

Considerably different to other headsets in this price bracket, the Avegant Glyph has eschewed the technology of mere OLED or LCD screens, in favour of projecting the image directly onto your retinas. It contains around 2-million micromirrors, which deliver a resolution of 1280 x 720 per eye, a refresh rate of 120Hz, but a field of view of just 45°. While this sounds very low, the image it creates is incredibly

sharp and entirely free from pixellation. It plugs into any HDMI-compatible device, will display both 2D and 3D content, and has built-in high-quality headphones with active and passive noise cancelling. These can be used on their own to play music, simply by rotating the headset so the eye band sits atop your head. It's also the most streamlined unit here. Perhaps better suited to watching

The Avegant Clyph is a chameleon, seamlessly morphing from VR unit to headphones

films and TV than hardcore VR gaming, it's nonetheless a fascinating piece of technology and one that other headsets will doubtless try to emulate as the marketplace matures.

"THE GLYPH PROJECTS THE IMAGE DIRECTLY ONTO YOUR RETINAS RATHER THAN VIA OLED OR LCD SCREENS" £70-£480.00

ACCESSORIES

The Virtuix Omni adds the feeling of mobility to the VR experience

These affordable extras will enhance your virtual experience...

£70.00

LEAP MOTION

I FAPMOTION COM

This portable hands-free motion controller can be fixed to the front of a VR headset, leaving your hands free to interact with the virtual world using grasping and pushing/pulling gestures. The Leap Motion is designed to be compatible with other VR accessories such as the Glove One, but that's not all. It also plugs into the USB port on Macs and PCs for use alongside a keyboard and mouse, offering another world of virtual possibilities.

"THE LEAP MOTION IS DESIGNED TO BE COMPATIBLE WITH OTHER VIRTUAL-REALITY ACCESSORIES SUCH AS THE GLOVE ONE"





£480.00

VIRTUIX OMNI

VIRTUIX.COM

One of the most successful VR Kickstarter campaigns last year, the Virtuix Omni allows virtual-reality gamers to walk in any direction without hitting a physical wall. It's supposed to be used with headsets like the Oculus Rift, and gets round players' reality blindness by allowing them to control their direction and speed of movement by walking on the spot. It works using a low-friction grooved base that the feet slide over, and comes with a support harness to secure players as they wander.

£138.00

VIRZOOM

VIRZOOM.COM

VirZoom uses frame sensors to turn stationary pedalling into virtual movement. The physical action happens in that red chassis where a multitude of sensors not only provide resistance, but steering, too. Elsewhere, optional action buttons on the handlebars offer advanced gaming controls. Will it make exercise more exciting and feel less of a chore? If it's half as successful as the Wii Fit, then the answer is yes.



£160.00

GLOVE ONF

GLOVEONEVR.COM



The Glove One is able to track movement and enable touch

Glove One is a haptic device that attempts to bridge the gap between touch and virtual reality. Slip the Glove One on your hand and, with the aid of a motion controller such as the Leap Motion, it can track hand movement and enable touch. The Glove One allows you to feel differences in texture, the weight of objects and resistance when interacting with objects, such as pulling open a heavy door.

£172.00 (PRE-ORDER)

FFFI RFAI

FEELREAL.COM

FEELREAL is a multi-sensory virtual-reality mask that's designed to augment headsets such as the Sony Morpheus and Oculus Rift and increase VR immersion, and boy does it have some tricks. Dual micro heaters and coolers respond to changes in the virtual environment and gently blow hot and cold air, while a motor provides vibration feedback. Amazingly, it also produces water mist to simulate spray, and even has an odour generator that takes seven unique cartridges for different scenarios.



The FEELREAL can change the climactic conditions of your virtual world

£207.00 (PRE-ORDER)

SIXENSE STEM

SIXENSE.COM

Sixense Stem is a motion-tracking system that can monitor up to five body parts using individual sensors. Two of these sensors are handheld controllers, working in pairs to track each arm independently, while the others attach to your ankles and waist for total motion capture. It works with a VR headset and replaces traditional controllers to heighten the sense of 'escaping the real world'.

The Stem monitors multiple areas of your body to capture every physical movement



N/A

BIRDLY

SOMNIACS.CO

At first glance this might seem like an April Fool's joke, and you certainly won't find it available on the high street any time soon. But this

virtual-reality
installation designed
by students at Zurich
University of the Arts
achieves what it sets
out to by offering VR
fanatics the chance to

experience bird flight. Paired with an Oculus Rift, Birdly lets users flap their 'wings' to travel faster in the virtual world, while the faster they go, the more wind they get blasted in their face by a big old fan.

Birdly has the ability to transform you into a virtual Icarus. Just don't get too excited and fly too close to the sun



£287-£4,600

360° CAMERAS

Making movies isn't the sole preserve of Hollywood: virtual-reality cameras are on the market from less than £300. Here are five across the fiscal board...

£300.00

RICOH THETA S

WWW THETA360 COM

The Ricoh Theta stands out from the current crop of consumer 360° cameras for being the most affordable and easy-to-use personal VR-capture device. Available for £300, the Theta S can shoot immersive video in 1080p HD at 30 frames per second for up to 25 minutes at a time. Variable shutter speed lets you get creative during active shoots, while its dual 14-megapixel, 1/2.3 CMOS lenses also take spherical shots with the click of a button.

Also thrown in is high-speed wi-fi support that enables you to broadcast your 360° movies via the Ricoh 'livestream' feature, or you can share your immersive media on social networks and supporting websites such as Google Maps.

And if you're not happy with how your movie came out, you can tweak the exposure and white balance of your videos while shooting thanks to the dedicated smartphone app, from which you can also view your recorded files. The additional free Theta+app lets you edit your shot spherical images and it's portable, too, meaning it won't end up gathering dust at home.

The Ricoh Theta S is highly portable and comes in an array of colours, both of which will hold great appeal to the younger generation

"HIGH-SPEED WI-FI SUPPORT ENABLES YOU TO BROADCAST 360° MOVIES VIA THE 'LIVESTREAM' FEATURE"



THETA ONLINE

Three examples of what you can expect of the Ricoh Theta S...

DRONE VIEW

If you've ever wondered what 360° spherical footage shot from a flying drone looks like, check out this stunning video at https://youtu.be/038NUuK8tWY.



BMX RACER

BMX stuntman and video producer Jon Lynn takes the Ricoh Theta S 360 VR camera for a spin around New York City at http://goo.ql/pCqTsX.



EVERYDAY LIFE

Although this 'concept movie' is essentially a commercial (https://youtu.be/lTZC3j_JbF8), it offers a good example of what can be achieved with the Ricoh Theta S.



£320.00

V.360

WWW.VSNMOBIL.COM

If you want to shoot sport in the new 360° format then look no further. It may look like it belongs in your kitchen, but the V.360 is shock and dust proof, and can even survive being submerged under three feet of water. Its built-in sensors include a barometer, altimeter and accelerometer, ensuring all your 1080p shoots keep right up with the action.



It might look like a blender but the V.360 shoots well and is bulletproof

£4,600.00

GOPRO 360 ARRAY

WWW GOPRO COM

This 360° rig holds 16 Hero4 cameras and can shoot 8K footage, synchronised using the array's high-speed connectivity. The mounting system allows it to be attached to a tripod or drone, but it's only available to Google content creators at the moment. That said, a consumer version is on the way – although bear in mind that the 16 cameras will set you back £4.600 alone.

You'll need deep pockets to go 'total GoPro' but the videos are impressive

£287.00

360FLY

WWW.360FLY.COM

The 360fly is another performer in the action-shot category. Its profile is about the size of a tennis ball, so it can be attached to a helmet or car. A single fisheye lens shoots 1440p video, the only limitation being that it captures 240° of spherical footage rather than the full 360°. Still, with intelligent positioning, the orb can capture an array of cool angles.



The 360fly is a rugged and portable beast, though only captures 240° instead of the full spherical 360°

£574.00

BUBLCAM

WWW.BUBLCAM.COM

Billed as the world's first spherical camera, the Bublcam is capable of shooting stills and video footage with absolutely no blindspots.

The sphere can capture in 1440p resolution at 30 frames per second, and with features for HDR and time-lapse photography (including tilt and VR pan options), we can see a bright future for the innovative device among 360° VR enthusiasts.



Bublcam captures film and images in 1440p resolution at 30 frames per second

YOUTUBE 360

The world's largest video-sharing website has gone 360...

YouTube 360 lets you interact with videos by looking around with your smartphone or tablet as they play. For even more immersion, you can watch the

videos with Google Cardboard. You can upload your videos through any desktop browser, as long as they've been given the necessary metadata using YouTube's free app. YouTube currently supports spherical footage shot at 24, 25, 30, 48, 50 and 60 frames per second on Ricoh Theta, Kodak SP360 and IC Real Tech Allie cameras. For best results, YouTube recommends to upload 16:9 aspect ratio stitched videos in 4K resolution.



£0-£2.32

REAL-LIFE APPS

Project yourself from your armchair into a dramatic world of heightened reality...

VRSE

WWW.VRSE.COM



Vrse is a production company specialising in

telling stories through liveaction VR filmmaking, and this app is the best way to experience their selection of high-quality 360 videos on your smartphone. Collaborations with the



likes of The New York Times, the UN. Vice and Saturday Night Live ensure a well-rounded exploration of the medium's potential.

VRSE also worked with U2 on their 'Song for Someone', so viewers could sit with Bono in their living room. iOS, Cardboard

> Jaunt offered fans the option to sit in the front row of a Paul McCartney concert

VIRTUAL HORROR

11:57

Horror lends itself well to VR, and this was one of the first apps to make the spectator the main character in a 360° nightmare. The dark atmospherics are supported by bone-chilling binaural audio. Free: Universal



THE BLACK MASS **EXPERIENCE**

Jaunt's eagerly anticipated immersive horror short certainly isn't for the faint of heart. What's more, it comes complete with an interactive sound field mixed in Dolby Atmos to really freak you out. You have been warned.

Free; Universal, Cardboard, Oculus Rift



INSIDIOUS VR

Elise Rainier (actress Lin Shaye) guides you into the horrors of the afterlife in order to navigate its furthest, darkest reaches, in this chilling VR experience based on the hit film franchise. Free; Windows, iOS, Android, Cardboard



JAUNT WWW.JAUNTVR.COM

JAUNT

Jaunt is another production company that aims to send viewers into story-driven worlds, simply through use

of their mobile device. A virtual Nepalese mountain adventure, a front row seat at a Paul McCartney concert and a trip inside North Korea as the country holds military celebrations highlight the breadth of scenarios Jaunt is covering. They also send you into film, like the 360° fashion photoshoot with Derek Zoolander (Ben Stiller) in Zoolander 2.

Android, iOS, Cardboard

"JAUNT SEND YOU INTO FILM, LIKE THE 360° FASHION PHOTOSHOOT WITH DEREK ZOOLANDER"





STITCHERS VR

WWW.STITCHERS.COM



This app is based on the television drama *Stitchers*. You're able to investigate crimes by transporting yourself into the deceased's memories. You can select the crime scene,

discover clues about the murdered protagonist's last moments and, using observation and logic, catch the criminal. You can also explore the crime scene without a VR viewer if you so wish. *Android, iOS*



£2.32

GO SHOW

WWW.GOSHOWAPP.BLOGSPOT.CO.UK



Movies are made for the big screen, and this app is a way to experience your video collection as the filmmakers originally intended. Simply, Go Show allows you to view your own 2D and 3D

movies (including panoramic 360° videos) on a virtual cinema screen. As long as the video is stored on your device in MP4 format, the app can render it in split-screen for true theatrical viewing. *Android, Cardboard*



FREE

GOOGLE CARDBOARD

WWW.GOOGLE.COM/GET/CARDBOARD



If you've just got hold of a Google Cardboard headset, then this is the app you should download first. Its 'Explore' section features guided tours of cities around the world, while

the 'Exhibit' section allows you to view museum collections as 3D objects. There's even a fun stereoscopic take on a classic kaleidoscope. *Android, iOS, Cardboard*



FREE

VOLVO REALITY

WWW. VOLVO CARS. COM/US/ABOUT/OUR-POINTS-OF-PRIDE/GOOGLE-CARDBOARD



VFX-studio Framestore partnered with R/GA and the Swedish car company Volvo to create this trio of experiential videos that allow you to get behind the wheel of the XC90 SUV carrier.

It's the sights and sounds along the way that make the trip really worthwhile, including some spectacular mountainous scenery. *Android, Cardboard*

£0-£1.99

CG APPS

While transporting to a virtual 'real world' appeals to your pragmatic side, computer-generated apps send you into the fantastical...





£0.79

INCELL

WWW.INCELL.NIVALVR.COM

This multi-coloured action-cumracing game takes place in a unique micro-world, which recreates the anatomy of a human cell in impressive detail, giving it an educational angle, too. Players ride along capillaries and connections as they take in inner space. The depth and scaling of the scenes really makes the experience worthwhile, and it has a rousing soundtrack to boot. iOS, Android, Cardboard, Oculus



£1.49

DINOTREK

WWW.GEOMEDIA.COM/VIRTUAL-AUGMENTED-REALITY



If you've ever wondered what it would be like to walk with dinosaurs then here's your chance

to find out. DinoTrek VR lets you get right up close to the prehistoric action, in which dinosaurs roam, fight it out amongst each other and, every now and then, just kick back and relax in the sun. Kids should love this app, which doesn't even require a headset to be enjoyed. T-Rex included.

iOS, Android, Cardboard



FREE

ORBULUS

WWW.VRCRAFTWORKS.COM/ORBULUS/



It's not just video that can be transformed with VR – Orbulus shows how still images can

take on a whole new dimension, too. The app's virtual environment allows you to explore a variety of 360° photospheres, in which you can stand on Mars, ascend Glastonbury Tor, experience New Year fireworks on Hong Kong harbour and a whole lot much more besides.

iTunes, Cardboard



£1.49

TANK TRAINING

WWW.DIGITALWORLDSTUDIO.COM



VR Tank Training uses a graphical 'mesh-blending' technique reminiscent of the popular

Battlefield games to simulate the experience of commanding a cannon on wheels. The idea is to destroy as many targets as you can while you manoeuvre your tank to the next checkpoint. There's also an in-game leaderboard for players to compete against each other for the top spot. *iOS*, *Cardboard*

FUNPARK RIDES

ROLLERCOASTER

Hurtle past city skyscrapers or zoom through a tropical island setting in this enjoyable and visually appealing simulator. Free; Android, iOS, Cardboard



CMOAR ROLLERCOASTER

Flaming lava pits, deserted mineshafts and devastated fantasy lands feature in this refreshing twist on classic rollercoaster games. £1.99; Android, Cardboard



CRAZY SWING

This virtual ride is hundreds of feet high and swings all the way round, making it a darn sight scarier than your average playground swing.

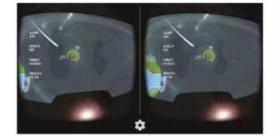
Free; Android, Cardboard



SWIVEL GUN! LOG RIDE

The carriage on this rollercoaster is fitted with a cannon and it's your job to shoot as many barrels as you can as the ride progresses. *Free; Android, Cardboard*





£0.76

WAA!

WWW.BICKHOFE.DE



WAA! lets you adopt the role of a cute little astronaut whose mission is to seek and destroy

asteroids or face a certain death. The game uses the focus control as a targeting device for launching homing missiles that, in the main, works extremely well. You can also collect batteries, screws and wrenches, which improve your aim, adjust gravity and restore shields.

Android, iOS, Cardboard



FREE

HANG GLIDING

WWW.I-MMERSIVE.NET/EN



Strap on your immersive glasses and explore a realistic and beautiful Alpine landscape from

the vantage point of a hang glider. At least, that's the theory. Tilting your smartphone left and right steers the glider and lets you explore the surroundings reasonably well, but the physics can be a little bit wonky. Still, it's a free download so we can't complain too much.

Android, i-mmersive glasses

SPACE EXPLORATION

COSMIC ROLLERCOASTER

Tour the Solar System from the comfort of your virtual carriage in this interstellar twist on classic rollercoaster games.

Free; Android, Cardboard



REFUGIO 3D SPACE STATION

Explore the vast interior of a space station orbiting the planet Refugio, complete with glass floors, viewing windows and a wicked sci-fi soundtrack. Free; Android, Cardboard



DEBRIS DEFRAG

Look around a beautifully rendered 3D space environment, and shoot asteroids from your path using your Cardboard headset and a controller.

Free; Android, Cardboard



GALAXY

This space-flight simulator is a demo of a game still being developed, but its arcade shooter elements are well worth a blast. *Free; Android, Cardboard*





FREE

SISTERS

WWW.OTHERWORLDINTERACTIVE.COM



This first-person ghost story sends you into a haunted mansion on the evening of an approaching storm.

You're all alone in a Victorian-era room — apart from an array of ominous-looking dolls beside the fireplace and the sinister noises echoing around the hallway. With numerous events triggered by your interaction with objects around the house, Sisters offers creepy set pieces and a good dose of suspense. *Android*, *iOS*,



UP TO £1.86

JURASSICLAND

WWW.NEOSUN.CO.KR



This dino-themed VR experience has more in common with *Jurassic Park* than other titles thanks to its

safari-style narrative. You're given the opportunity to drive off-road in a jeep and get up close with the most famous dinosaurs, including Giganotosaurus, Triceratops and T-Rex. This gives kids a real sense of scale to the animals, which makes up for some mediocre graphics.

Android, Cardboard



FREE

A CHAIR IN A ROOM

WWW.ACHAIRINAROOM.COM



Horror experiences don't get any simpler than this. You begin in said room, a dark and dingy

environment, with no explanation as to where you are or how you got there. Soon the lights begin to flicker and falter, and the terror of your situation gradually becomes painfully clear. Interaction is minimal at best, but it's another fine example of VR's potential in the horror genre. Android, Cardboard



FREE

ROCKET DROP

WWW.SCOTTGAMES.COM



This skydiving game is a virtualreality take on the original Rocket Drop, a first-person outing in

which you fly around courtesy of a jetpack with the aim of avoiding missiles being constantly fired at you. Collecting fuel capsules keeps your jetpack operational, so be sure to make the most of the gyroscope head tracking of your Google Cardboard and keep an eye out for them.

Android, Cardboard

FREE

WAR OF WORDS

WWW.BDH.NET



This BAFTAnominated animated reading of

Siegfried Sassoon's poem
'The Kiss' is a brilliant
demonstration of virtual
reality's storytelling
possibilities. To recap, The
Kiss was written just before
the Battle of the Somme –
where more writers and
poets fought than any
conflict in history – while
Sassoon was on an armytraining course. Narrated
by Michael Sheen and



"SIEGFRIED SASSOON'S KISS IS A BRILLIANT DEMONSTRATION OF VIRTUAL REALITY'S STORYTELLING POSSIBILITIES" developed in partnership with *BBC Arts*, War of Words may be on the short side, but it is beautiful and poignant, and perfectly captures the controversial and battling spirit of the original work. *Android, Cardboard*

FREE

CARTOON VILLAGE

WWW.VRCODEX.COM



Cartoon Village drops you into a colourful medieval

cartoon settlement where you're free to investigate any nook and cranny you fancy. The extreme level of detail gives the rural enclave a real lived-in feel, and you can simply change the season and time of day to see how it affects the habits of its dwellers and the surrounding natural world. It's also available on Android but only as



wallpaper. Additionally it can run in Daydream mode on devices with Android 4.2 or higher. Cartoon Village has already taken the mantle as cutest CG-rendered app in the world of virtual reality.

iOS, Cardboard

"CARTOON VILLAGE DROPS YOU INTO A COLOURFUL MEDIEVAL CARTOON SETTLEMENT WHERE YOU'RE FREE TO INVESTIGATE"

LONDON'S MOST CUTTING-EDGE COMPANY?

Shoreditch-based Inition are at the forefront of VR and AR technology. Our reporter spent a day immersed in another world...

Words: Luke Edwards



hanks to augmented reality, virtual reality and smart sensors, we're moving virtual objects with our hands as if they were real. It's a brave new world of technology-driven reality, and pioneering

that future is British tech specialist Inition.

The London-based outfit was founded in

The London-based outfit was founded in 2001 by three computer scientists – Jim Gant, Andy Millns and Stuart Culpit – and has been at the frontier of exploration into the worlds of virtual and augmented reality ever since. By finding, developing and adopting the latest hardware technologies, Inition has a track record of creating new and innovative ways to use VR, 3D printing and more. And that's why we spent a day in their capable hands...

MERGING OF CULTURES

Combining art, science and tech is the lifeblood of Inition, who've researched and developed a plethora of mind-blowing projects. In 2012, they built a wing suit for Nissan that let its occupants feel like they were flying thanks to an old-style VR headset, fan, smart support and immersive audio. Inition also attracted headlines in 2014 when working with the *BBC* to 'facilitate the world's first 3D broadcast', capturing Brian O'Driscoll and Jack Nowell in all their glory at the Six Nations.

More recently, Inition was in the press again for creating a virtual catwalk show where five competition winners could watch London Fashion Week's main event. They were placed in VR headsets and sat in Topshop's window to experience the fashion show; at the same time,

they became a form of art themselves. Working with the London Philharmonic Orchestra, Inition also turned the foyer of the Royal Festival Hall into a virtual-reality access point to view and listen to the performance in complete surround – a first for the venue.

2016 is projected as the year that VR will finally gain a foothold, with commentators suggesting the VR and AR markets will be worth around \$150-billion by 2020. From what we saw – and as you'll discover overleaf – Inition look set to be at the vanguard of this evolution but, despite the optimism, Inition's

"INITION HAS A TRACK RECORD OF CREATING NEW WAYS TO USE VR AND 3D PRINTING"

Jay Short warns that manufacturers mustn't blindly slip into the Emperor's New Clothes. "Virtual reality is still in its infancy, and we must be careful or it may never reach the mainstream. Bad content is damaging. That's why we must create great experiences now so people can see just how amazing the future of virtual and augmented reality can be."

That's been Inition's mission for 15 years from their Shoreditch base, which is a utopian showcase of that tech. Now prepare to have your eyes opened to a different world, a virtual one that's right here, right now...











1 Inition worked with the London Philharmonic, filming the worldrenowned orchestra with 3D cameras

- 2 The London-based outfit teamed up with Topshop to give five competition winners 'front-row' seats at London Fashion Week
- **3** Visitors to the London Philharmonic could recap the performance in the Royal Albert Hall foyer
- 4 Inition used binaural microphones to enhance the audio experience
- **5** The Royal Albert Hall foyer also featured cinematic screens to get up close and personal with the orchestra
- **6** By placing them in the Topshop window, the winners became a piece of art in themselves





INSIDE THE STUDIO

VR WING SUIT

This is the 2012 creation that shot Inition to fame and still leaves everyone that tries it in awe. Nissan commissioned Inition for the project, the Japanese car company coming up with the unusual brief of skydivers attempting to assemble a virtual Nissan Juke while freefalling. And the car giant wanted it finished in just six weeks.

In that timeframe Inition managed to create its own magnetically tracked, head-mounted display, which they rapidly prototyped and 3D printed. Inition's next task involved building from scratch an ergonomic flight platform to accommodate all shapes and sizes of people, which also reacted to movement, before then installing a DMX-controlled fan. Finally, the team had to calibrate everything to work in conjunction with the bespoke software and the user's movements. It was an impressive achievement.

Since 2012, the wing-suit experience has been re-skinned and upgraded several times, so when we tried it during our day's visit, the experience was even more immersive than four years ago. It's truly amazing how the suit really takes your breath away, cleverly fooling the body into experiencing motion.

2 PHYSICAL TOUCHSCREEN

Big data and the trends it can lead to are fascinating and integral to defining the shape and aims of societies. Take the example of health trends, which are an ever-growing resource for spotting and treating illness, be they physical or mental. The problem comes when relaying that information to the public. Pie charts, graphs, table of numbers... these are common platforms used to communicate information, and all are pretty uninspired and dull. That's where Inition entered the fray, who were tasked with making data interesting and more immersive.

The result? A giant touchscreen-cumtable... but not a touchscreen as we know it because, as Short says, "Normal touchscreens are everywhere and simply don't excite." So Inition opted for a collaborative touch interface from

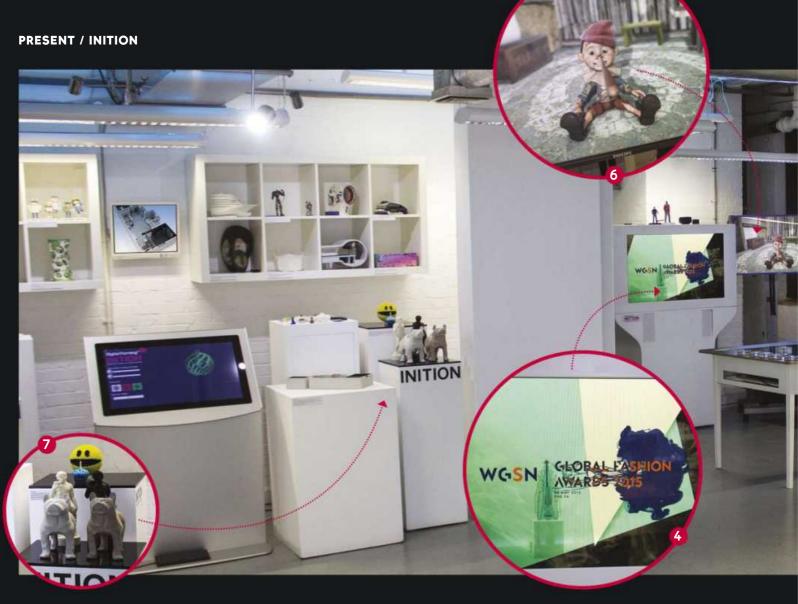


"INITION OPTED FOR A TOUCH INTERFACE THAT FEATURED AN ARRAY OF INFRARED SENSORS" Finnish company MultiTaction, which also features infrared sensors. By shining this light up through the display, it's able to detect objects based on the shapes of markers. In this case, glass pucks that represent a different sport.

Placing these markers on the tables opened up a plethora of data readout options relating to the sport. For instance, twisting and moving the physical puck allowed for stacking and organising. After having a go, we were impressed with how intuitive it is and how addictive, leaving you feeling like







we've ended up with people clinging on for dear life. This is what we're learning – there are so many tricks to create the best VR experience."

TRANSPARENT SCREEN

The transparent screen is something that's starting to appear outside of labs as a means of showcasing products. Inition has used it for just this reason in the past. But what makes it particularly cool is that there are even options for touchscreen interactions with the screen.

The idea is that you can see the product physically – say a pair of trainers – but then graphics make it come to life by overlaying images using the screen in front. The next step could be to let users move the physical object using the touchscreen, presuming said objects were on a linked-up turntable.

The possibilities are endless, and it's a step towards merging the real and the virtual but without the need for bulky headsets. Still, at nearly £8,000 each and an easily breakable glass front, shops aren't snapping these up too quickly.

5 7SPACE 3D MANIPUL ATION

The ZSpace display and interactive pen allow for virtual objects to be manipulated as if they were really there. Using optical trackers and 3D glasses, the screen displays three-dimensional objects that can be looked at from different angles. A stylus acts as a hand, gripping the virtual object so it can be manipulated. The unit is around £2,000 and is often used by universities, where Inition regularly showcase their units and knowledge.

One example Inition showed to onlooking students was of a human skull. The team at Inition demonstrated how doctors and those in training could examine and work with the skull as a way of taking a closer look at a particular injury. From there, they could more accurately prescribe a remedy.

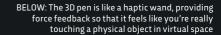
Beyond that it can also be used by graphic designers, 3D modellers and moviemakers to create and manipulate virtual objects as if they were in the real world. This is a first step towards what augmented reality could offer us in the not too distant future.

6 STEREOSCOPIC 3D DISPLAY

The Inition screen employs layered stereoscopic 3D, meaning sense of depth is created even without glasses. And that offers the potential of opening up the insular nature of VR. It also overcomes the issues of glare and VR technology being hard on the eyes. Stereoscopic 3D allows anyone to use the displays to draw people in, even on the street. The downside? Stereoscopic 3D screens need to be looked at from just the right position or the screen layers are revealed and the illusion is shattered. You may have already seen this technology used by advertising companies at airports, and you're very likely see more of them in the future.

3D PRINTED MODELS

As we've shown, Inition has used 3D scanning and 3D printing to create a huge amount of objects, like human skulls for medical students. They were also involved with the team at *Top Gear Live*, the project involving prototyping a physical object to show off the speed of the technology used. Another job Inition







ABOVE: An augmented reality iPad is just the start. The future will see objects overlaid on the real world but without the need for a tablet

INITION 6

carried out, this time for Crossrail in London, saw them create a version of the tunnels so that the engineers could actually see at scale what was going to be created. This helped to save money by planning for problems ahead of time. When you consider how affordable 3D printing can be, these savings are even greater.

Inition has even 3D printed moulds that allow museums to create multiple miniature versions of exhibits to be sold affordably. When asked why Inition

"INITION WERE INVOLVED WITH TOP GEAR LIVE TO SHOW OFF THE SPEED OF CUTTING-EDGE TECHNOLOGY"

doesn't simply charge for making its own, the response was: "We're not just about money – it's the passion for technology and finding new ways of using that tech which drives us."

8 3D PEN CONTROL

This is essentially a more physical version of the Zspace with the haptic pen suspended by an arm that responds to movement. With your haptic wand, you're given force feedback so it feels as though you're really touching the object in the virtual space.

Inition has discovered that it's proved very popular for the medical professional to manipulate virtual body parts. A combination of haptic feedback and augmented reality could see the future welcome a blend of virtual objects in the real world that actually 'feels' like they are there being manipulated.

9 AUGMENTED REALITY IPAD

Using an iPad, Inition created an intelligent augmented-reality app that responds to movement. The result was a

virtual representation of a building project that could be moved around using the tablet, like it was really there. Thanks to extremely high resolution and impressive detail, you can move the tablet closer to effectively zoom in for a close-up of the build.

"Virtual reality is great but it has its limitations. For instance, it can be a very solitary experience," says Short. "That's where augmented reality works well. It empowers the user so, rather than a PowerPoint presentation, individuals can take the information in as they please, which actually helps them absorb it far easier."

The future will see these types of virtual object overlaid on the real world but without the need for a tablet. At tech conferences around the world, much talk has focused on AR headsets for all-day use and even advanced contact-lens screens. Inition are understandably excited about this technology but throw in the caveat that we shouldn't expect to see it anytime soon. The closest we have is Microsoft HoloLens but even that's developing slowly.



VIRTUAL SUCCESS

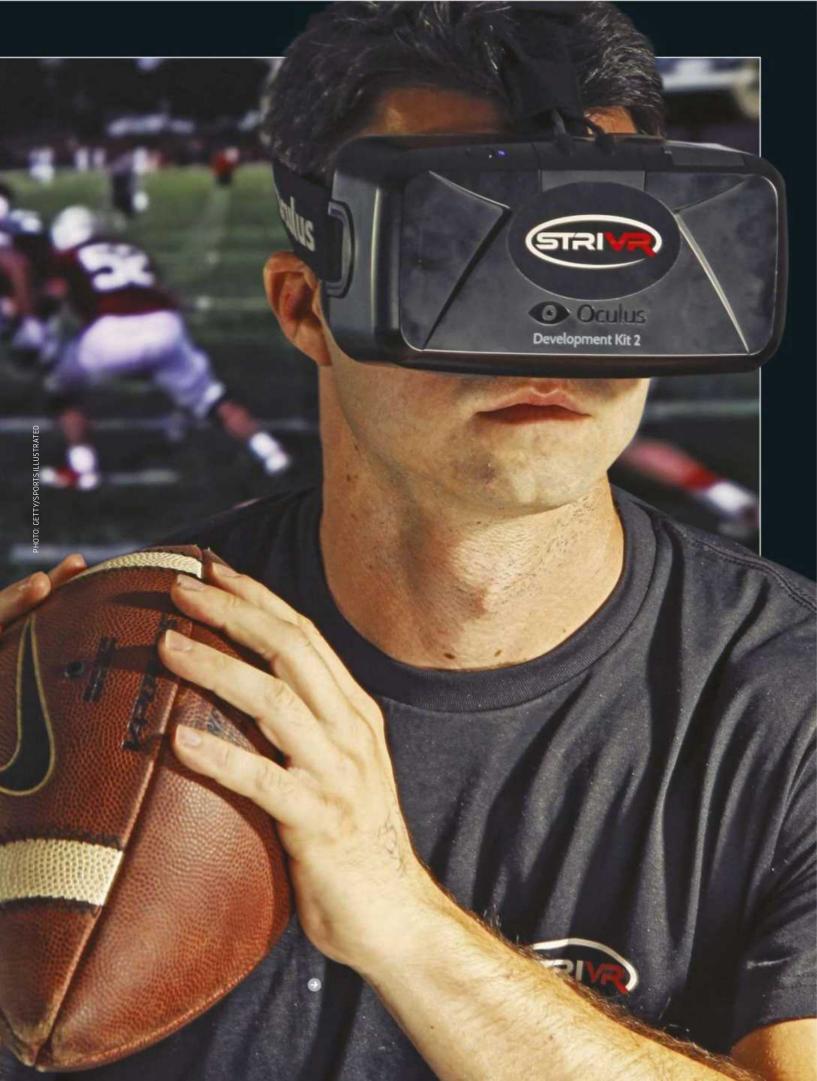
THE BENEFITS OF VR ARE FILTERING THROUGH TO PROFESSIONAL CLUBS AND MEDIA OUTLETS ALIKE. WE **EXAMINE ITS IMPACT ON SPORT...**

WORDS: JAMES WITTS

ou burst from midfield. To your left is Messi; to your right is Neymar. Should you continue striving toward the opposition's goal or pass to one of your teammates? Sadly, your indecision costs you as Sergio Ramos tackles you before laying off to Ronaldo who makes it Real Madrid one Barcelona nil. This is no schoolboy dream. It's not only the future of virtual-reality sport in gaming, but it's happening right now in real life. "We use virtual reality for two

aspects of sport," explains Brendan Reilly, CEO of EON Sports, experts in the field of VR sporting application. "There's the training application and then there's the spectator side. Both enhance the user experience."

With its interactive, immersive and multi-sensory qualities,



"American football team the Tampa Bay Buccaneers are already employing EON's VR technology"

it doesn't take a leap of imagination to see how VR can benefit sporting participants. Let's say you're a quarterback in American football. Too often, with the pressure on, you succumb to the opposition's charging defensive tackle and are sacked. Why? Because anxiety overcomes your decisionmaking, spatial awareness flies out the window and you're dumped on your glutes.

With VR, you can place yourself into that same scenario and receive a 360° recall of where your defence is. where the opposition's defence is, and the movement of your wide receivers and running backs. "Immersing yourself is basically a more refined method of replaying sporting footage," adds Reilly, highlighting studies that have shown athletes who use VR improve decision-making (albeit this is in the short-term - longer studies are required to determine lasting benefits).

"You can then learn which move might be more efficient than the one that had you sacked."

NFL team the Tampa Bay Buccaneers are already employing EON's technology, which utilises real-life and CG sporting situations, as well as a number of collegiate football teams and a handful of baseball teams. "We're also engaging with European soccer teams but we can't say who," adds Reilly. So numerous sports are realising the potential benefits of VR, though its use is sports-specific.

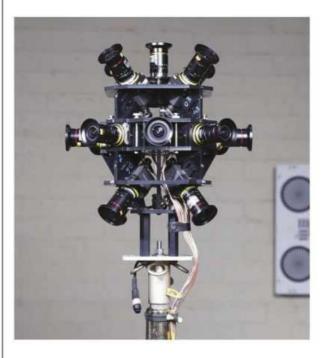
"VR application varies depending on the activity," explains Reilly. "In baseball, we utilise a large VR room that athletes walk into – it's like a VR hall deck – and they slip on these glasses and feel like they're transported to the baseball environment. They'll then practise throwing or striking. In American football and soccer, it's more headspace training – an understanding of strategy – where we use the Oculus Rift or Samsung Gear VR."

EON aren't the only ones. At February's NFL combine (where college football players seek contracts with professional teams), former Stanford kicker Derek Belch debuted STRIVR – a programme specifically designed to enhance game-film study and train quarterbacks by allowing them to relieve games they've just played. It certainly worked for Stanford quarterback Kevin Hogan, who by common consensus had the three best games of his career after using

FILMING VR

Virtual logistics

Behind the scenes with US production company Headcase...



Headcase is an American virtual-reality production company who are currently developing projects for a number of high-profile clients including Nike, Chevvy, FX and Ticketmaster. They also have an ongoing relationship with the Pac-12 Conference, who provided the foundations for Headcase's project 'A Behind The Scenes Look'.

Headcase utilised virtual reality to take viewers inside an American football stadium, sending them into the middle of a collegiate team huddled together while the players elicited a collective war chant. The team also captured much of the action, applying multiple cuts at the editing process to create the impressive piece of sporting 'cinematography'.

Key to recording the footage was the specially engineered 360° camera system, engineered and built for specially directed sporting shots. As you can see from above, the video camera rig featured a number of cameras arranged in a spherical shape and captured images at 23.98 to 60 frames per second. Resolution came in at 1,920 x 1,080 with footage recorded on 12-bit raw files 'with premium-quality C-mount lenses'. The camera was then mounted on a mobility platform for ease of use around the pitch.

Though the production team had planned specific shots in advance and spent significant time in the editing suite, Headcase are confident that full games shown in virtual-reality are imminent.



STRIVR. It impressed Dallas Cowboys enough to sign up STRIVR on a two-year contract.

VISUALISATION AND PACING

VR won't just benefit team sports where tactical acumen and fine skills are key to success. 'Power' sports like running and cycling will benefit, too, and that's down to visualisation. Visualisation is a technique adopted by the world's greatest sportsman where they mentally run through the race or game in the build-up to the actual event.

"All top athletes engage in mental imagery," says cognitive neuroscientist Ian Robertson. "They go through their routines beforehand, sometimes in real time. If you do brain imaging of people when they're undertaking mental imagery of that kind, almost all the same parts of the brain that are active when you're actually doing it are active. It's only the final pathways tied in with sending signals to the muscle down the spinal cord that aren't active."

Steve Backley, the former British javelin thrower, was renowned for spending as much time visualising his throw than the physical action. When he injured his knee in the build-up to the 2000 Sydney Olympics and couldn't physically train, he devoted tens of hours this mind, and run through the warm-up preparation and normal run-up and throw, all in real time. On his return to throwing, he took silver.

"It was clearly a worthwhile exercise," says Robertson. "The higher the correspondence of your mental moves to your physical movement, the greater the mental stimulation and the better the athlete."

With VR, visualisation will become even more precise. Runners will be projected into the race or stadium and more accurately immerse themselves in the upcoming competition. With VR, you could show the runner what it feels like to run faster.

Studies have shown that once a runner subconsciously realises they can raise their pacing template without harming themselves, they can then replicate this increased speed in real life. In short, will VR hold the key to breaking the two-hour marathon!?

VIEWER EXPERIENCE

It's not just sporting participants who'll benefit from virtual reality – the spectator will be immersed in the VR world, too. In early March this year, Sky announced the launch of a virtual-reality film studio that will produce videos for Oculus Rift, Samsung Gear and online 360° video platforms like Facebook 360 and YouTube 360. To celebrate



SPORTING APPS

BASKHEAD

Follow in the giant footsteps of Michael Jordan and co, though slamdunks are achieved with a nod of the head rather than a leap. £2.82; Android, PC



MOTORBIKE VR

The choice of two motorbikes and numerous race tracks transforms you into a modern-day Evil Knievel. Free; Android, iOS, PC



LUGE CRUSH

Watched the Winter Olympics in envy of athletes pelting down a bobsleigh run on an aerodynamic tray? Well now you can join in... £1.40; Android, iOS, PC



SHANE WARNE: KING OF SPIN

See if you can handle the Australian legend's googly and wrong 'un, all from the comfort of your VR unit.

Free; Android, iOS, PC



their VR entry, Sky showed two VR films during Formula One testing with the Williams team over in Barcelona where you're taken into the pits and driven around the Spanish track, all in 360.

It's the first of 20 films Sky will make this year thanks to four full-time VR camera operators and staff from across the Sky company, which will seemingly grow year on year as VR takes off.

"The technology to film is there, the technology to view it on is there and the platforms are there," says Neil Graham, head of VR production at Sky. "What we need to do now is populate them." As well as Formula One, Graham says other sports will experience the VR treatment. Already planned for release are VR videos covering Anthony Joshua's bid to win a world title and a film following Chris Froome and his Sky teammates as they attempt to retain the Tour de France title. Google has also recognised the potential

of the sports market, recently giving away free 30,000 Google Cardboard units to New England Patriots fans.

"If the NFL give us the go-ahead, we could livestream American football from as early as

next season"

SPORT FOR ALL

It's not just media heavyweights who are getting in on the act. Start-ups like Next VR have worked with the NFL this season, capturing three football games, before showing them at the Super Bowl in January at the fan convention. The viewer watched the action from five different angles and areas on the field, the footage then edited together for a 'truly immersive experience'. However, according to their chairman, Brad Allen that's

just the start. "We're ready to livestream an event today. If the NFL give us the go-ahead, we could do it from next season."

Virtual-reality outfit IM360 also filmed David 'Hayemaker' Haye's comeback boxing match in 3D, which was available via Haye's 360Haymaker app and involved a 360° camera set-up atop of one of the ring's corners. Disappointingly for viewers, their VR experience didn't last long, Haye knocking out opponent Mark de Mori in just 131secs.

VR in sports still has issue to overcome, including longevity – and we're not just talking potential motion sickness. I mean, watching an entire cricket test match in VR could test the most avid fan. Still, the potential to transform sporting participation and viewing is huge. And with so much money driving this most tribal of entertainment, you can bank on virtual reality soon becoming a mainstay of sport.

last fight was shown on his 360Haymaker app. Sadly, it didn't last long, opponent Mark de Mori remaining upright for a mere 131secs BELOW: Sky has set up a VR studio. One of their first ventures involved 'testing time' with Formula One team Williams

PHOTOS: GETTY, SKY X4









CONFRONTING - AND BEATING - TRAUMA

POST-TRAUMATIC STRESS DISORDER IS SADLY ALL TOO COMMON IN RETURNING SERVICE(WO)MEN. THANKFULLY, THERE'S GROWING EVIDENCE THAT VR CAN PROVIDE AN EFFECTIVE TREATMENT

WORDS: ROBERT BANINO

R's growth in popularity stems from transporting individuals to simulated environments that present no real, physical danger to the person immersed in them. Being simulated also means those environments can be precisely calibrated to deliver a tailored scenario appropriate to that person. These two characteristics make VR a valuable tool for

conducting 'exposure therapy', in which patients with anxiety-related conditions, such as post-traumatic stress disorder (PTSD), repeatedly confront the cues that trigger their stress reactions.

Prototype VR exposure therapy applications began appearing in the 1990s but were held back by capabilities of the technology available at the time. But as the technology improved, so too has VR therapy's potential. Now it's reached a point where all branches of the US military are funding a VR PTSD treatment developed specifically for servicemen and women returning from the wars in Iraq and Afghanistan.

"Traditional exposure therapy to treat PTSD relies on imagination alone; the person has to imagine the situation related to the trauma," explains Albert 'Skip' Rizzo, director of medical virtual reality at the University of Southern California's Institute for Creative Technologies. "But one of the cardinal symptoms of PTSD is avoidance — avoidance of the cues and reminders of the trauma. So it's a tall order to expect someone to create a vivid mental image of something that they've been spending their whole time trying to avoid.

"We take that same exposure therapy protocol but deliver it using VR simulations so that we're not relying exclusively on the person's imagination," Rizzo continues. "We place the person in VR simulations that the clinician can control in real time and customise based on that person's experience."

RECREATING TRAUMA

The therapy starts with a discussion between the patient and the clinician to determine if the VR therapy – christened 'Bravemind' – is appropriate. If so, a traumatic memory is selected and used as the basis for a virtual scenario. The patient can then be immersed in that scenario for up to 40 minutes at a time during the 10 weekly sessions.

"The clinician has what we nickname a 'Wizard of OZ' control panel, and they start by selecting one of the 14 VR worlds that we've created," says Rizzo. "These worlds vary from a highly populated Middle Eastern city, to

PHOTO: GETTY

0

Marine Merkle experienced first-hand the benefits of virtual therapy after active service in Iraq and Afghanistan



Name Chris Merkle Regiment First Marine Division Active Service 2003-2010, three tours in Iraq, four tours in Afghanistan

"The first couple of times using Bravemind were hard. I was disorientated and nauseous, partly because you have the headset on but also because you're bringing up difficult memories. It was 10 years since the invasion of Iraq to the time I started speaking about it and a lot of emotions were buried deep down. I'd tried traditional psychotherapy and wasn't getting results. I had a good therapist but I couldn't talk about the deep, dark things. I think she realised that there wasn't one big trauma incident, so we couldn't get down to the root of the problem. She's the one that suggested trying the Bravemind project.

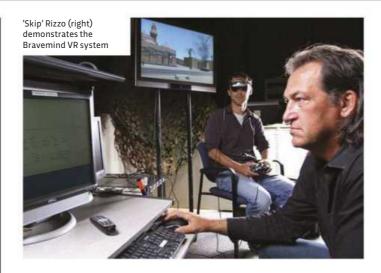
"I had to pick a scenario to be created in VR carefully. It has to be something that's bothering you but nothing that's going to trigger you to the point where you can't talk about it or you're going to break down. I chose one of my days during the initial invasion into Iraq with the US coalition. Some of those days were really long; you didn't really have a base to work out from – you were just driving all day from Kuwait towards Baghdad.

"And it turned out that it was actually a big day for me. Driving through Nasiriyah, I was exposed to 30 different stimulus situations, any one of which could cause of PTSD. You're seeing unbelievable things and inflicting carnage and it's one [trauma] event after another but you keep on driving. You don't process it.

"Those Bravemind sessions were the first times I talked to somebody about my deepest issues so, after the initial painful reaction, I felt calmer. I could deal with everyday situations better and was less stressed out. It gave me time to rationalise when faced with a stressful situation. I didn't have a yellow light before; it was either green or red.

"I've gone back to the traditional psychotherapy now but Bravemind was a big key that helped me unlock the majority of my problem. It might not be right for everybody but, for me, it was a great success."

"Olfactory stimulation is incorporated by a compressor that blows air over phials containing scents like body odour and diesel"



• marketplaces, mosque areas and slums, to Afghanistan villages and remote mountain outposts. The clinician can put the patient in that world and systematically adjust what goes on in it."

Once the background to the experience has been decided upon, it's then a case of questioning the patient to tailor the scenario to their recollection. For instance, were they driving a vehicle, on a foot patrol or manning a gun turret? Did it take place at dawn or later in the day? What sort of noises were heard...?

"All this begins to set up the experience in a way that's relevant to the patient's trauma experience," Rizzo explains. "As they work through this narrative retelling and begin to confront and process these difficult emotional memories, the clinician can make things happen to heighten the realism. He can set off an IED (improvised explosive device) nearby, have a helicopter or a jet fly over, or insurgents appear on a rooftop and fire an RPG (rocket-propelled grenade)... It's never going to be an exact replica of the trauma experience but it's close enough to engage the patient in their trauma memories and stir up imagination, all in the context of the safety of the therapeutic environment."

A SCENT OF RESOLUTION

Further 'realism' can be added by engaging the patient's sense of smell. Olfactory stimulation is incorporated by a compressor that blows air over phials containing pellets impregnated with scents such as body odour, gunpowder, burning rubber or diesel. "I'll say right upfront that we don't have the data to say whether odours add to the clinical effect," says Rizzo. "But we do know that smell is intimately tied in the brain with memory and emotion. So we feel it's theoretically informed and an important thing to add."

All of which makes Bravemind sound like an amped-up computer game. But to view it as such is to misinterpret the intention behind it, says Rizzo. "The goal in a game is to find the biggest weapon you can get your hands on and lay waste to everything. If we thought fostering a cathartic revenge fantasy was a healing method for PTSD then we could just use games. But it doesn't. The difference between a game and Bravemind is that we're trying to help the patient to confront and process difficult emotional memories.

"Bravemind is about reliving traumatic experiences in a safe environment, so that the experience becomes paired



HOW BRAVEMIND FITS IN

Virtual reality is one element of exposure therapy to treat individuals suffering from post-traumatic stress disorder...

EDUCATION

Therapy begins with education about the upcoming treatment. The service(wo) man will also learn about common trauma reactions and PTSD. Education allows the individual to learn more about their symptoms and understand the goals of the treatment, laying the foundation for future sessions.

BREATHING

Breathing in a relaxed manner helps the individual to relax. When people become anxious or scared, their breathing changes. Learning how to control breathing can help in the short-term manages immediate distress.

REAL-WORLD PRACTICE

This is where VR fits in. You approach situations that are safe, but which you may have been avoiding because they're related to the trauma. An example would be a veteran who avoids driving since he experienced a roadside bomb while deployed. This type of exposure practice helps trauma-related distress to lessen over time.

TALKING TRAUMA

Repeatedly talking about trauma with the therapist is called 'imaginal exposure', and will help the solider gain more control over thoughts and feelings about the trauma. They learn that they don't have to be afraid of their memories. Talking through the trauma helps to make sense of what happened.

with the safety and support of the clinical environment," Rizzo continues. "Gradually, the patient no longer experiences the same level of conditioned fear or anxiety that had previously occurred from the recall of their trauma memories."

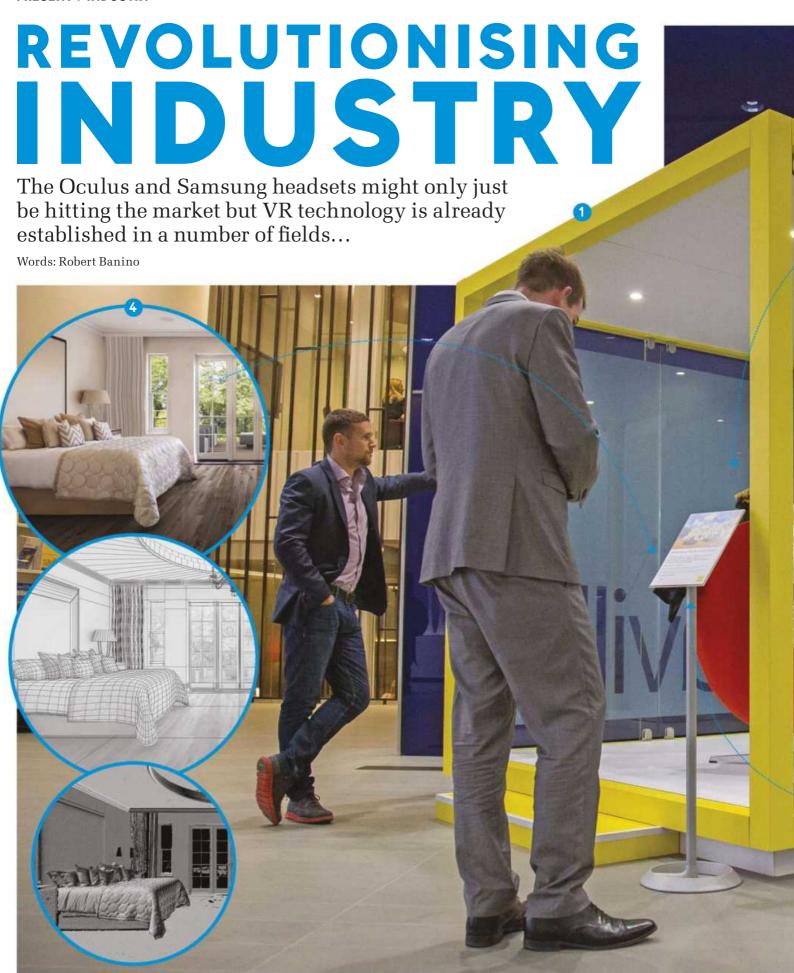
STATISTICALLY PROVEN

Trials of an earlier version of the virtual therapy that Bravemind was developed from proved promising with 80% of the patients that completed the treatment showing statistically and clinically meaningful reductions in PTSD, anxiety and depression symptoms. The patients themselves also claimed to have noticed lasting improvements in their everyday life.

So are VR treatments, such as Bravemind, a better alternative to traditional exposure therapy? "Some scientists say adding other elements to the traditional exposure therapy doesn't really matter — you're not going to get any better clinical outcomes. I'm not in that camp," says Rizzo. "I think that the complexity of PTSD calls for other elements



that go along with the traditional therapy to help support the patient. It's not therapy delivered by machine. It's not designed to replace a clinician. In the end it's simply a tool to extend the skills of a good clinician to better deliver an already evidence-based therapy for PTSD. Ultimately, that is virtual therapy in a nutshell." •





| REAL | ESTATE

Of the many stresses you encounter on the joyous journey of buying a house, the time and costs involved when viewing properties are among the biggest inconveniences. And those inconveniences are multiplied if you're looking for a home in another country.

Photos, 360° videos and Skype viewing give potential buyers a taste of the properties they're considering but they don't solve the problem completely. To enjoy a more rounded appreciation of the house and its interior space, you need to get inside it, which again requires travel and expense. Unless, that is, you can wander around the prospective properties remotely, which is precisely what VR allows you to do.

In July 2015 UK estate agents Savills unveiled Horoma, a system that let interested parties take a selfguided tour of the £16.75-million mansion Furze Croft in Surrey.

Horoma, created by the virtual-reality production company Rewind, utilises laser scanning to build a virtual reproduction of a house's interior and head-mounted displays to let customers wander around inside. Currently it's only a demo to showcase the technology, but Savills hopes Horoma will become a valuable tool in the marketing of properties.

Similar technology is already being used in Los Angeles, California, where the Michael Hood Real Estate Group is providing VR tours of its high-end properties in Beverly Hills and Malibu.

- 1 UK estate agents teamed up with VR technology company Rewind to build a virtual reproduction of a house's interior
- **2** Consumers used Oculus Rift headsets to virtually experience the palatial surroundings
- **3** The demo property was certainly palatial, the £16.75-million Surrey mansion coming with a private cinema, indoor pool and 1,700-bottle wine cellar
- **4** Key rooms were scanned, allowing depth data to be combined with photogrammetry for 'a realistic and important feeling of space and scale'

10TOS: REWIND:VR, SAVILLS ESTATE AGENTS

ARCHITECTURE

US company IrisVR has developed software that enables 2D plans to be viewed in 3D The problem at the heart of architecture is scale. Designing a building at full size is clearly not practical, so architects make their plans using scaled-down drawings and models. That helps but communicating a 3D design on a 2D format – in other words, a sheet of paper or a computer screen –

doesn't give you a true appreciation of the space within a structure. VR provides a solution by allowing architects to render their designs in 3D and at full-scale within a virtual environment.

Companies such as IrisVR in the US are developing software that enables architects to drag and drop designs into a VR programme before donning an Oculus Rift or HTC Vive headset to walk around within their building.

VR modelling also enables architects to see how much space is needed for people to use the interior effectively. As such, when British-firm 3d Architects submitted its updated shop-floor proposal to the Boots pharmacy chain, it included a virtual-reality shop furnished with the new design to see how customer navigation might be affected.







O3 EDUCATION

Archaeology students at Harvard may not be able to travel back in time but, thanks to VR, they can roam around Egypt's Giza plateau and see how it would have looked around 2500BC. Using photos, maps, notes and the excavation diaries of the Egyptologist George Reisner, an approximation of the entire site has been rendered in a virtual-reality landscape.

Life-size models of the pyramids of Khufu, Khafre and Menkaure, along with the Great Sphinx and other structures in the necropolis, have been created by Dassault Systèmes as part of a joint venture with Harvard University and the Museum of Fine Arts, Boston. The virtual model is the only place where every temple and tomb structure on the Giza plateau can be seen reconstructed together.

How does it work? Inside the Visualization Center in Harvard

University's Earth and Planetary Sciences Department, students don 3D glasses and sit in front of a 23-foot semi-circular screen onto which the Giza reconstruction is projected. The students can then decide where to go and which element they'd like to examine in detail, including the subterranean shafts and burial chambers.

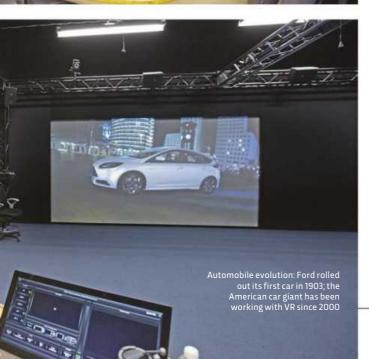


Thanks to VR, Harvard's archaeology students can roam around ancient Egypt









\bigcirc 4

AUTOMOTIVE INDUSTRY

A challenge for car manufacturers is marrying the design aesthetic with the practicalities of fuel efficiency and aerodynamics while making the end result appealing to the consumer. It can be a long, laboured and costly process but one that's becoming more streamlined thanks to VR. At Ford's

headquarters in Michigan, the American car behemoth has use of an ultra-highdefinition VR facility that allows its designers and engineers to sit inside life-size virtual versions of prototype vehicles. As well as showing them a full-scale, 3D model of the proposed car, the Ford Immersion Lab also lets engineers see beneath the bodywork to examine how its

In 2013 alone, the Immersion Lab was used to check 135,000 details

mechanical systems work.

on 193 prototypes, and resulted in changes to the wing mirrors on the Ford Fusion (Mondeo) and windscreen wipers on the new Mustang. Ford's certainly confident in the technology after being one of the early adopters all the way back

in 2000, where they employed it to refine the bodies and cabins of

Ford
used virtual
reality to check
around 135,000
separate car
details

its range of cars.

And it's not just the designers who are benefiting. At CES 2016, Audi announced virtual

showrooms will soon become the norm. Working with Nvidia Quadro GPUs and VR suppliers Oculus and HTC, Audi is introducing the new concept to allow customers to experience

Audi vehicles there and then, even if the specific model isn't stocked by the dealership. Audi expect the first showroom to go live in the US later this year.



ABOVE: Designers utilise VR headsets to refine everything from the engine to the chassis



Thomas Cook customers could accurately preview potential holidays

TOURISM

Nobody is seriously suggesting that VR could be an alternative to actually going on holiday but it has a role to play in marketing trips overseas. In 2014 British travel agency Thomas Cook teamed up with VR production company Visualise to produce immersive experiences of the holidays they offer.

Customers visiting the Thomas Cook branch in the Bluewater shopping centre could slip on a Samsung Gear VR headset and be instantly transported to one of the many locations the company arranges travel to. Achieving this required the Visualise staff flying to Egypt, America and the Far East over a period of months, and

shooting 360° footage of the attractions and activities holidaymakers could experience in those places.

Without leaving the shop in Kent, customers could stroll among the Pyramids, scuba dive in Sharm-el-Sheikh, take a helicopter tour of Manhattan or walk across the OCBC Skyway suspended 22m above Singapore's Marina Bay. When it comes to choosing a potential holiday destination, it certainly beats flicking through travel brochures. Thomas Cook seems to think so, at least, as the VR system is said to have led to flights and hotel bookings totalling £12,000 in the UK in the three months after its official launch in 2015.



Simulators

refine their

handling

skills



FLIGHT SIMULATION

Aircraft simulators are the most tried-andtested 3D technology on the market Flight simulators first appeared in 1976. The VR environment in 'A2FS1 Flight Simulator' was limited but, in the 40 years since, VR flight simulators have become a sophisticated and crucial training tool. "It's all about bringing affordability and safety to pilot training," explains Atul Patel, director of advanced technologies at Lockheed Martin, a manufacturer of military simulators. allow pilots to "From the military perspective, a lot of aircraft are singleseaters and training a pilot to fly one of those is more difficult [as the instructor can't accompany the traineel. That's where

simulators come in.

"We ensure the virtual aircraft's dynamics are modelled accurately so the pilot can understand exactly what's going to happen when he's flying the real plane," adds Patel. As the pilot's skill increases, the simulators allow the instructors to

introduce new challenges to keep the trainee progressing.

"If you're training a pilot to land on a aircraft carrier, we can induce crosswinds on the final approach, which is a very dangerous situation in reality but a pilot has to learn to handle it," Patel says. "As they improve, we can make the carrier

deck pitch and roll, which frankly you wouldn't want

> a trainee to encounter in real life, but in a simulator he can learn to deal with that situation safely."

VR flight simulators aren't just the preserve of pilots with engineers and

mechanics benefiting, too. "Think about the complexity of the aircraft and their engines," says Patel. "Having a virtual capability to learn how to access and work on them is critical. And a virtual environment is a more affordable and quicker way to train the mechanics than having to put them to work on a real aircraft."





LEFT: VR enables the dentist to view the tooth or jaw from different angles

MEDICAL TRAINING

Dentistry is one of the leading pioneers in the application of VR technology. Take student dentists at King's College London who've been using the HapTEL Virtual Dental Lab – essentially a virtual-reality mouth – to develop their drilling skills since 2010.

Instead of peering down into a patient's mouth, the undergraduates sit over a monitor that displays a 3D representation of either a specific tooth or a complete jaw. By wearing special glasses that track their head movements, the students are able to examine the tooth or jaw from various angles.

They work on the tooth using a replica drill that provides haptic feedback to give them the sensation of drilling into a real tooth. The feedback is sensitive enough to help the trainees differentiate between drilling into healthy or decayed enamel – a skill that's



crucial to prevent them from applying too much pressure and damaging the patient's teeth, gums or jaw.

The
HapTEL unit
is £30,000
cheaper than
traditional
tools

Aside from
eliminating the risk of
injuring real patients
while the new dentists
train, a key advantage
of the HapTEL Virtual
Dental Lab is cost. One
HapTEL unit costs £10,000

but prices for the mannequin heads filled with plastic teeth – the previous training method – reach up to £40,000. Also, the plastic teeth could only be drilled once and cost £16 each to replace.

Other branches of medicine are also starting to appreciate the potential benefits of VR training. In 2015, the Miami Children's Hospital began collaborating with Next Galaxy, a VR content developer, to build VR software that trains people to perform lifesaving emergency procedures, such as cardiopulmonary resuscitation or clearing blockages from a choking person's throat.

Next Galaxy has worked with the Miami Children's Hospital on several VR projects THE FOCUS COLLECTION

THE

BBC FOCUS

This new compendium of the best articles from BBC Focus Magazine explores the current state of Earth, how we can protect it from global warming and natural disasters, and what would happen if we left to colonise another planet.

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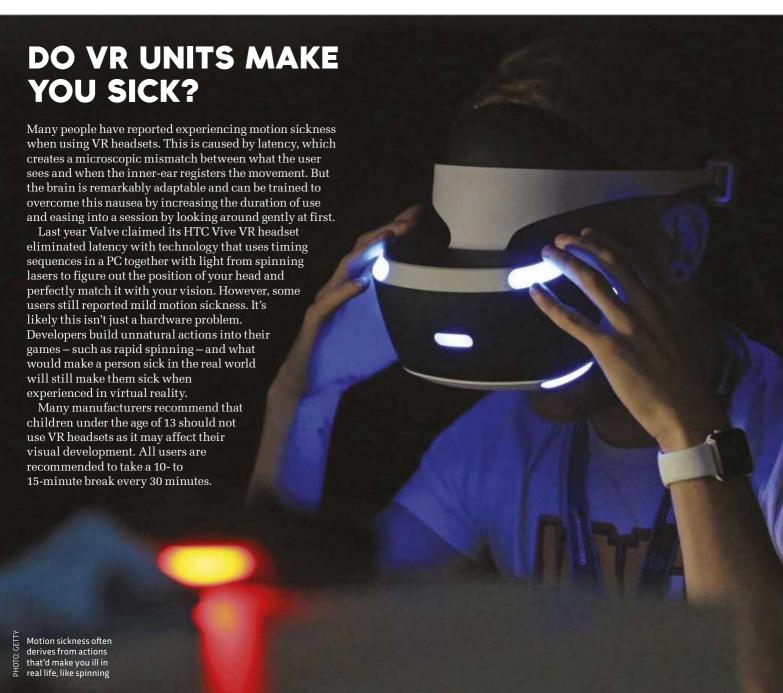
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FROM THE MAKERS OF BBC FOCUS MAGAZINE



Kate Russell is a technology journalist of over 20 years. She's also a broadcaster and is a regular on BBC technology show Click





Is it true that VR can cure phantom pains in amputee victims?

There are some scientific case studies to show that using signals from a limb stump to control a virtualreality limb can, indeed, dramatically reduce the phantom pain experienced by some amputees. These treatments are still in the early experimental phases, however, and while the results are promising, they will need to be tested in controlled clinical trials before any conclusive claims can be made.



FUTURE-PROOFING VR

Will VR units become more streamlined?

Tech makers are always looking to streamline and reduce the size of their gadgets, especially as one of the enduring criticisms of VR headsets is that they are bulky and uncomfortable to wear. We can already see with devices like the Microsoft HoloLens, which has a development headset due out in 2016, that sizes are likely to reduce drastically in the first few iterations of the genre. Interestingly, Microsoft is also incorporating augment reality, which will allow its headset to play mixedreality programmes. At an eye-watering \$3,000, though, it might take a while for the price-tag to be streamlined, too.

Another development with the potential to reduce the weight of headsets lies with the display technology. Avegant's Glyph is currently available in the USA and China, and uses an array of micro mirrors to reflect an image directly into your retina rather than the smartphone-like screens used in other devices. In the more distant future, Sony has already patented an idea that may lead to the beaming of ultrasonic waves into the brain to recreate our senses, the end result of which remains to be seen.



IN NUMBERS

\$30 billion

is what industry experts forecast the VR industry could be worth by 2020

171 million

users worldwide are expected to be plugged into VR headsets by 2018



Yes. You should be able to plug a Raspberry Pi into any VR headset that features an HDMI input. That's all you'd need to run VR programmes on the affordable mini-computer. That said, Raspberry Pi

tells me that they are still some distance from being able to give people the opportunity to work on programming their own VR environments, but that's a software tool issue rather than a hardware issue. For this to happen, ideally a VR headset manufacturer would need to release their developer tools to Raspberry Pi, who tell me they would be delighted to hear from them!

OPTICAL SOLUTIONS

CAN I WEAR GLASSES WHEN USING VR?

That largely depends on the VR device being used and the size of your glasses. My relatively small frames fit comfortably inside most devices I have tried, like the simple I AM CARDBOARD viewer and VR-One headset. More advanced headsets give you some control over focus, in which case you may well find you don't need glasses at all as you can adjust the lenses to compensate. Other headsets, like Oculus Rift, come with several different lenses that the user can switch around to provide the best results. The only way to be sure is to try the device before buying.









LIFE-CHANGING?

I've heard that virtual reality can encourage people to save for their retirement. Is that true?



Several years ago, a team of researchers at Stanford University, California, developed a 'virtual reality experience' that allowed people to look into an 'aging mirror' and see their future selves, aged 64 years old. Among myriad of results, the study showed participants generally

allocated twice as much money towards a hypothetical savings account following the future encounter. However, there is no evidence to suggest that virtual reality had anything to do with these results other than delivering a more immersive experience.

Have Blippar any plans in VR?

Currently Blippar have one VR app on the market – a game to be played on Google's I AM CARDBOARD called Cardio VR, which aims to teach kids about medical conditions within their bodies. The company tells me they are looking to further develop and explore the VR space this year, including using mixed reality with VR and AR combined, but cannot disclose any specific details at the time of writing.



IN NUMBERS

The fantastical Magic Leap looks set to appeal to users of all ages

1968

saw the world's first head-mounted virtual-reality display, The Sword of Damocles, developed by Ivan Sutherland and Bob Sproull





A NEW CAREER PATHWAY

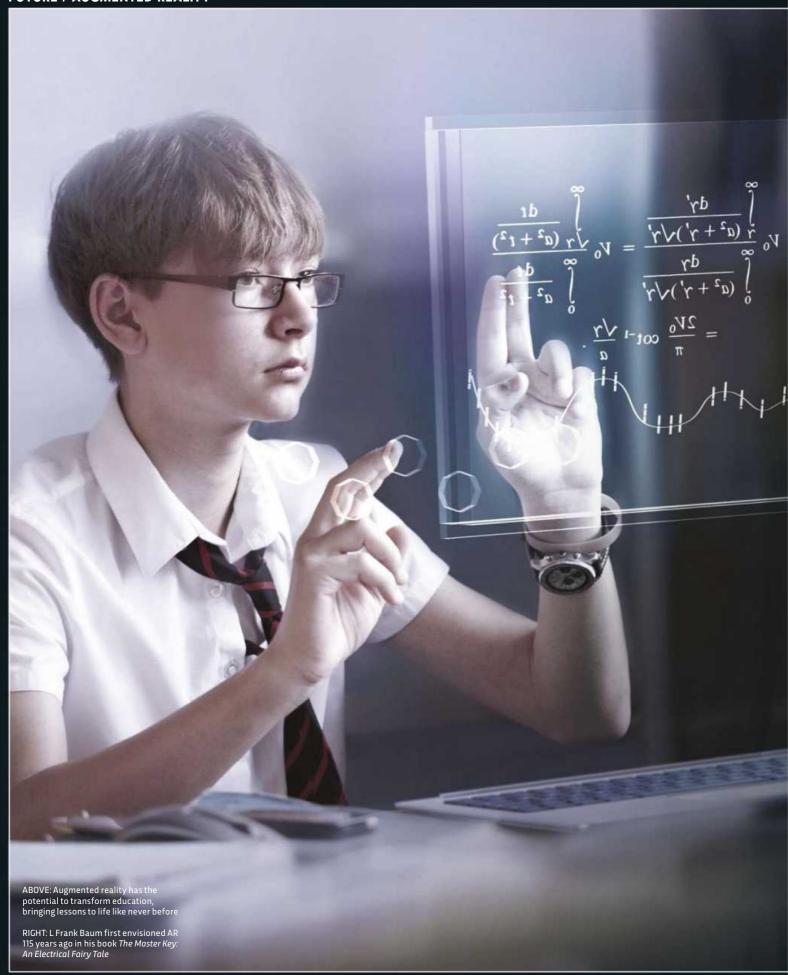
How do I become a virtual-reality designer?

Many of the technologies used in developing virtual reality are already commonly used in computer game design and by architects and product designers. That's why skills like software development, digital modelling, 3D and computer-aided design, and meta language like XML and HTML are essential. There are currently a handful of specialist virtual-reality courses available at higher education institutions in the United Kingdom, but we can expect this number to grow in-line with the expansion of the market. Some of the more generic software/computing degrees also offer virtual reality as a module. Heading to 'thecompleteuniversityguide.co.uk' is a good place to start if you want to search for courses currently available in this field.





VR isn't just a novel gaming option – its impact will change how we interact as human beings. We investigate how it'll revolutionise news and social platforms, as well as revealing why augmented reality could be even bigger



TOMORROW'S WORLD

AUGMENTED REALITY IS SET TO CHANGE
THE NATURE OF ENTERTAINMENT, INDUSTRY...
AND LIFE AS WE KNOW IT

WORDS: DAVID BODDINGTON

n 1901, the Wonderful Wizard of Oz author, L Frank Baum, first envisioned augmented reality. In The Master Key: An Electrical Fairy Tale, a young boy is given a special pair of spectacles by the Demon of Electricity, which overlay character trait information for everyone he meets. Little did Baum know that, just over a hundred years later, this technology

would become reality. But it wasn't until towards the end of the 20th century that the term 'augmented reality (AR)' was itself first coined, and engineers and developers began to take things seriously.

STATE OF PLAY

Unlike virtual reality, where an entire world is generated and displayed to the viewer, AR is where real-world places are seen by the eye or depicted on-screen and supplemented by computer-generated, real-time, audio-visual material. These can be simple 2D data representations or, as with Microsoft's HoloLens, interactive 3D holograms anchored to real-world objects.

From choosing the best restaurant while walking down the street, to replacing a heart valve from a thousand kilometres away, the potential for AR to affect almost everything we do is enormous. With over six-billion people expected to have smartphones by 2020, the overwhelming majority of the world's population will carry with them all the technology they need to take advantage of basic AR.

With internet connectivity and apps, users can hold their phones up in front of a foreign menu, have it translated into their mother tongue and overlaid onto the image. You can try it for yourself right now with the free Google Translate app: "Je voudrais que les escargots et une bière s'il vous plaît".

Wearable AR technology is also a growing sector with helmets featuring visors already in use in the construction and engineering industries.

They have real potential to increase efficiency of workers, while eyeglass AR devices have also found their way onto the mainstream marketplace.

Bionic contact lenses and VR displays are also soon to be unleashed on consumers, and as with so many forms of technology, with miniaturisation comes mass-market appeal. But what does the future hold for AR? In industry, especially when coupled with haptic technology (which provides motor-driven feedback to the user), AR could make the world a much smaller place yet again, and

increase the influence and productivity of international experts in many different fields.

UNDER THE KNIFE

Already, wearable AR devices are being trialled for use by surgeons during operations. Anchoring themselves to a mark on the patient's body, the AR unit can then superimpose animated steps in the procedure, highlighting key anatomical features including nearby vulnerable tissues, and even

1AR will become more popular in surgery, projecting key anatomical features into the patient's yet-to-be incised body

2 Military potential is huge, stretching from the control room to the frontline

3 Astronauts including Tim Peake are using Microsoft's HoloLens unit on the International Space Station

4 Volvo is already working with Mircosoft to produce the next generation of automobiles









PHOTOS: NASAX3, SCIENCE PHOTO LIBRARY, ALAMY, REX

advising on the correct equipment to use at any moment. This is undoubtedly the kind of knowledge surgeons already possess, but having AR as a guidance tool frees them up to focus fully on the patient. Along with remote surgery and haptic feedback systems, this will allow top surgeons around the world to share their expertise in training and live operations.

FUTURE SOLDIER

It's not just clinicians who'll benefit. Military personnel in air forces and navies around the world will be familiar with heads-up display (HUD) AR technology, but for troops on the ground in the US Army, there is a step change coming in the form of DARPA's ULTRA-Vis technology.

This moves away from the separate screen information source of the old Nett Warrior system, in favour of an AR HUD that doesn't interrupt the soldier's view of the environment. Instead, the glass lens that rests in front of one eye has a system of channels etched into it, onto which a pico projector overlays the pertinent information. Everything from the location of tactical objectives to aircraft can be tracked and overlaid within predetermined parameters, even without direct line of sight.

In fact, there's almost no limit to what could be displayed in real-time. Enemy positions, streamed video from drones and live squad status updates all are possible. The fact that this degree of technology has been made public means we can only speculate about what kit various military organisations around the world are keeping behind closed doors.

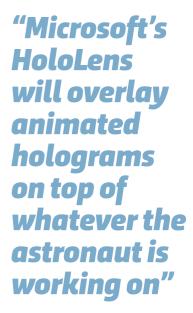
It's easy to imagine a near future where, following contact with the enemy, artificial-intelligence-guided orders could be given on-the-fly to an entire combat unit via AR, overlaying onto the environment the precise timing and direction of movement and firing for every man or woman.

THE FINAL FRONTIER

In December 2015 AR made one giant leap in space exploration, as Microsoft's HoloLens technology made its way to the International Space Station (ISS). In a partnership known as 'Project Sidekick', NASA and Microsoft hope to

make life simpler for astronauts on board the ISS by utilising HoloLens' AR capabilities to expedite all manner of necessary tasks in orbit. NASA's Dan Huot explains that, "We see augmented reality being a great tool to make the astronauts even more efficient in their work, whether that's conducting scientific experiments or repairing systems on board the station."

In one of the modes being tested, HoloLens will automatically overlay animated holograms on top of whatever the astronaut is working on, in order to



EDUCATION

AR IN THE CLASSROOM

Augmented reality will redefine the way we teach our students...



Augmented reality has the potential to revolutionise the way we teach our children, and bring lessons to life like never before. US teacher and AR advocate Drew Minock believes that 'AR is already changing the way we learn'. And he's already applying it in the classroom...

FNGLISH

"Each year our students would do a writing project using a visible thinking routine called 'Step Inside'. The students would slip into the shoes of a character and write from their perspective. They would then create a drawing to go with their writing. The students were never very 'excited' about this project until we introduced

augmented reality. We had the students dress up as the character and record a video of them reading their writing. We would then attach that video to their drawing with augmented reality. Parents were able to bring these projects to life at our student showcase using the DAQRI [smartphone AR] app."

MATHS

"I decided to record a 1-2-minute mini lesson and attach it to each night's homework using augmented reality. If a student needed help or a refresh from the day's lesson, they could open the DAQRI app, scan the homework, and get a short mini lesson using the vocabulary and examples from that day's class.

It yielded powerful results for struggling students."

SCIENCE

"Augmented reality in science just makes a lot of sense. Applications like Elements 4D allows you to print paper blocks, and use them to explore elements from the periodic table using augmented reality. This provides a completely new medium to explore the content, and also allowed students to interact with dangerous materials like mercury in a completely safe manner. Students can also use many augmented reality applications to explore the solar system, or use Anatomy 4D to learn about the human anatomy."





WEARABLE TECH

0

SMART GLASSES

Experience the world of augmented reality with these advanced optics...







£412.00

LAFORGE SHIMA

WWW.LAFORGEOPTICAL.COM

• Laforge's AR glasses have avoided the bulk of many competitors, and have instead developed a system that streams data from your smartphone directly to your designer-look frames. You can even order them with prescription lenses.

£519.00

EPSON MOVERIO BT-200

WWW.EPSON.CO.UK

2 Epson's 'affordable' AR glasses are powered by Android, meaning there are many apps available to run on the device. It has a battery life of up to six hours and it can even play 3D movies.

£543.00

ORA-1

WWW.OPTINVENT.COM

3 The ORA-1 glasses claim to have unparalleled see-through lenses, so your real-world vision is not overly obscured. Switching between full AR mode and glance mode will also allow you to control how invasively you want data displayed.

£2,099.00

MICROSOFT HOLOLENS

WWW.MICROSOFT.COM

Microsoft's HoloLens is currently the most exciting AR product out there. Although only development kits are currently available, the everyday life integration the product promises suggests this could be the market leader for some time.

£2,764.00

ATHFFR

WWW.ATHEERAIR.COM

dimed squarely at 'deskless professionals' the Atheer Air AR headset is designed to provide useful documents and real-time data onthe-fly to workers in heavy industry, healthcare, logistics and beyond.



supply them will all the information they need, thus increasing their efficiency.

But the potential for NASA and Microsoft's partnership extends much further. NASA's Huot says, "AR could be a boon to improving not only the efficiency of astronauts on deep-space exploration missions, but also their autonomy. As we move beyond

"With haptic technology, you could physically feel the holograms that you see in front of your face"

Earth, everything gets more difficult. You experience massive communication delays, spare parts are limited and abort scenarios become difficult to non-existent. The big takeaway is a lot more responsibility is transferred to the crew members to be more self-sufficient as they don't have folks on the ground there for immediate assistance."

HOME COMFORTS

Of course, AR doesn't always have to be serious. The potential applications in the home are also very exciting. While watching live sport on your flatscreen TV, for example, an AR headset like HoloLens could allow

you to increase your viewing angle, seeing the entire stadium projected around your living room, essentially giving you the best seat in the house!

Additional information on player stats, tactics, league standings and much more besides could be accessed and hover in the air next to your sofa, just by saying a player's name or making a gesture. AR could

also completely change how we visualise and interact with games like *Minecraft*, allowing the world you're building to be secured to your living room floor.

Especially exciting is the promise that this kind of software could be coupled with haptic technology, allowing you to physically feel the holograms you see in front of you. Among others, researchers at the University of Tokyo are using ultrasound waves to create acoustic radiation pressure, giving perceived substance to virtual objects without the need for special feedback gloves, potentially bringing a whole new dimension to gaming experiences.

In the kitchen, AR tech will be able to automatically scan your shelves and project recipe suggestions onto the wall. Virtual to-do and shopping lists could be pinned to the fridge to make sure you never again have an excuse to ignore the DIY or miss items off the weekly shop. Going to a party and not remembering someone's name will be a thing of the past, too, as their key Facebook data could be overlaid onto your invisible smart contact lenses, along with their most recent cat/baby pictures. Just as L Frank Baum doubtless envisaged it.

Augmented reality was conceived in 1901, grew in the 1990s and is today just about learning to crawl. However, in the blink of an eye it'll be running. Increases in portable computing power mean that headsets will quickly shrink and that will lead to much wider mainstream adoption. And once this reaches critical mass, big business from all sectors will pour money into the space, just as we have seen with smartphone software over the last decade. The explosion in AR is nigh...

David Boddington is a freelance science writer who's also a dab hand at video production.





With iPhone sales stagnating, the evidence is growing that Apple is investing heavily into the fast-paced world of VR

Words: Alex Dale

I

t's testament to the hold Apple has over consumers and the industry that even the most banal of statements can positively or negatively impact

upon the technology sector. Rewind to the hardware giants' Q1 2016 earnings report, where Apple CEO Tim Cook was asked his opinion on VR. He replied, simply: "I think it can be really cool and has lots of interesting applications."

Hardly a ringing endorsement. But evidence is mounting that with sales of iPhones tipped to fall for the first time ever in 2016, Apple are looking to branch out from their core business of consumer electronics. One rumoured tangent is 'Project Titan' – a high-tech electric car in development via the input of around 1,000 engineers. But progress on Titan has purportedly stalled due to a lack of confidence about its direction.

TITAN POTENTIAL

Enter VR and AR. With their untapped potential for real-world applications, both may yet provide the link between Apple's traditional expertise and movement into new areas like automobile. As an example, Titan could be bolstered by a windscreen that overlays directions and hazard warnings onto real-world elements, like that that being developed by automotive giants PSA Peugeot Citroën.

Indeed, while Cook is non-committal in public, behind closed doors Apple are investing heavily in VR technology, acquiring numerous start-up companies with expertise in the field and hiring



The Israeli company behind the 3D sensor technology that fuelled Microsoft's original Xbox Kinect, allowing the console to read the layouts of 3D spaces such as living rooms. It was originally assumed PrimeSense would work on the Apple TV, but the tech could also benefit an AR device.

PrimeSense



The Cube is a VR research centre based within the Moss Arts Center on the Virginia Tech campus

Reportedly, the VR/AR team is a separate division consisting of hundreds of experts, and they're already experimenting with numerous headset configurations. Apple aren't talking publicly about their plans, but delving deeper into the talents involved

reveals insight into what they might be planning.

Apple's interest in VR dates back to the midnoughties. Unearthed patents reveal prototypes with typical Apple flourishes like the ski-mask design from 2008 that features breathable foam, which rests against the user's face for comfort. Other patents point to more practical applications: a picture-within-picture display that would allow a user to keep an eye on the world around them, and a headset with an advanced zooming feature that effectively transformed it into a set of next-

generation binoculars. All of these ideas were eventually scrapped.

"Apple is showing keen interest in the role sound plays in the immersive VR experience"

OVERCOMING NAUSEA

Brianna Wu, a video-game developer with extensive knowledge of both iOS and VR tech, believes Apple's late entry into the sector is because they feel the tech isn't yet at a point where Apple can provide the kind of sleek, desirable experiences that define their products. "If you think back to the iPhone's launch, it debuted at a very high price point," says Wu. "The truth is we already had

cheaper touchscreen tech at the time but it didn't work so well. The iPhone was a premium product, and both the touchscreen and the interface had to reflect this." Wu suggests Apple could make a smartphone-VR product tomorrow but, she says, potential nausea is an issue they're yet to overcome at an affordable level.

"Apple is a company that's very friendly to women, and women experience VR sickness at a rate much higher than men do," she explains. "To overcome this on a dedicated device, the hardware has to render the experience in 60 frames per second, so your eyes don't know the difference, and track your movements so fast that your biological systems can't tell. And it has to do it twice - once for each eyeball. This is one of the most computationally expensive things you can possibly do."

Currently there isn't a commercially available Mac in the world capable of running something on the level of Oculus Rift, with Oculus CEO Palmer Luckey laving the blame at the door of Apple's primitive graphics processing units.

Instead, many argue it makes sense for Apple to leverage their huge iPhone user base by developing a phone-mounted VR headset to rival the likes of Samsung Gear VR – and a patent dating back to 2010 reveals Apple has been working on such a device for some time.

However, according to Peter Pashley, head of development at ustwo - a studio that developed 'Land's End', a VR adventure game for Samsung's device - current iPhone tech lags behind its rivals. "There's a lot that can be done in software, both within the VR app and at the iOS level, but current generation iPhone screens are too low resolution and too 'smeary' for VR," explains Pashley. "They would need a screen resolution of at least 1,440 pixels and some form of low-



METAIO

Beginning life as a side-project at Volkswagen, Metaio is an augmented-reality company with many impressive apps under their belt, such as Time Traveler, which enables users in central Berlin to hold their iPad in front of them to see what the world around them looked like in the time of the Berlin Wall.

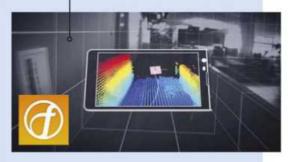
FACESHIFT

The Swiss studio behind the motion-capture technology in Star Wars: The Force Awakens has created software that transfers a person's facial expressions onto an animated avatar in real-time. Not technically a virtual-reality company, then, but it's easy to imagine how VR apps could use the technology.



FLYBY MEDIA

Apple's most recent purchase is Flyby, a tech offering that allows mobile devices to 'see' the world around them. The Flyby app lets you scan in a real-world object – for example, a coffee cup – which you can then send messages to. Your friends can then read the message when they're in close proximity to the item in question.



persistence-of-vision tech, most likely OLED screens similar to Samsung's flagship phones." The latter is important in eliminating blurring effects when you turn your head.

AUDIO EXPERIENCE

But with many billions sitting in reserve, Apple look intent on refining the VR experience. In particular, Apple appears to be showing interest in the role sound plays in the experience. Last year, Apple Music teamed up with production company VRSE to create a 360° VR video for the U2 song 'Song for Someone', in which the music changed dynamically as the user moved their head to look at various musicians. That musical interlude provided a hint of Apple's direction – as does the acquisition of Nick Thompson.

Thompson was the Audio Hardware Engineering lead on Microsoft's HoloLens device, which uses two speakers on either side to create a spatial sound effect, meaning you can identify the direction the sound is coming from. Another high-profile hire, Doug Bowman, previously worked as a computer science professor at Virginia Tech. Among the projects Bowman worked on there was something known as 'The Cube' - a 10-foot x 10-foot enclosure designed to enable cutting-edge virtual reality research. Among the high-end toys available within The Cube is a 360° audio system containing 124 speakers, which enables 'unique aural experiences', such as what it'd feel like to stand in the middle of the tornado.

Bowman's most celebrated work, however, involves 3D user interfaces. His CV includes being principle investigator of Virginia Tech's 3D Interaction Group, which researches immersion and user experience in 3D spaces. It's an area that's currently very clunky and, well, un-Apple-



In 2015, Apple teamed up with production company VRSE to create a 360° video for the U2 tune 'Song for Someone' like, so it's likely Bowman will be tasked with creating an intuitive interface, perhaps building on previous patents around haptic (touch) control schemes. It's a direction that'll pay dividends, according to Wu.

"Many are focusing too much on the graphical aspect and not how you interact," she explains. "In my opinion, things won't catch fire until its use is as simple as swiping on an iPhone, whether that means haptics or other intuitive gestures. If anyone's going to solve these issues it's Apple."

Apple's reputation is built on 'creative workarounds' that make their products more comfortable, accessible and desirable than the competition. But there's one issue they might never lick. "The technical bottleneck with phones isn't necessarily the processor," says Wu. "You could put A9 processors in an Apple device tomorrow and have it work. The problem would be the battery life." A familiar story, perhaps, for any iPhone owner.

Alex Dale is a writer and editor who specialises in science, technology, travel and space.





thing? One of the leading standard-bearers for VR journalism is Nonny De Le Pena, a former Newsweek reporter and documentary film-maker who's now CEO of Emblematic Group, a company based in LA that creates 'immersive journalism' projects. These include Hunger In Los Angeles (about LA's food banks), Use Of Force (about brutality by US border guards) and Project Syria, a piece commissioned by the World Economic Forum about life in Aleppo during the current civil war.

De La Pena's films work in mixed media, combining the 'real' with CGI to tell real-life stories (see *Q&A* box for more). Project Syria, for instance, looks at the aftermath of a bomb explosion. Everything you hear in the film is real audio captured at the scene, while the witnesses you hear describing the events are people that were actually there. But the explosion you see onscreen is a CGI rendering created using the Unity games engine, and the people scurrying around in its aftermath were motion-captured by De La Pena at her studio as they re-enacted the event later on.

The point, says De La Pena, is that "the spatial narrative really lets you feel the whole thing with your whole body, not just through your eyes and your mind. It's pretty extraordinary, actually. That's the big advantage".

SUPPORTED BY SCIENCE

Scientifically speaking, De La Pena seems to have a point. VR journalism is such a new field that research into its impact is thin on the ground, but studies of the use of VR in gaming and education back up De La Pena's logical conclusion that a story will have more impact if you "feel like you're there".

In 2007, Susan Perksy and Jim Blascovich's paper 'Immersive Virtual Environments Versus Traditional Platforms: Effects of Violent and Nonviolent Video Game Play', published in the journal *Media Psychology*, showed that gamers became more emotionally involved with games played using VR headsets. And in 2011, research at Stanford University's Virtual Human Interaction Lab found that while people who took part in a VR

"How do you ensure that what's recreated actually reflects reality?" simulation of logging in the rainforest and another set who merely read about it both declared a wish to reduce their own paper consumption afterwards, only the former group actually did so.

In gaming and education, then, VR systems offer

greater engagement and ensure the take-home message stays with you longer – it's natural to imagine the same will be true of news.

ZUBR MAKING WAVES

With fully immersive, 'true' virtual reality still some way off, hybrid approaches like De La Pena's are pretty much the norm right now. Another company that's working in the field is Bristol start-up Zubr, who are pioneering a blend of virtual reality and augmented reality (AR) techniques. Using their method, 3D VR content can be captured with depth-sensing cameras, then embedded in a flat image (much like a QR code). When this image is viewed using a smartphone-and-goggles combo, the 3D image comes to life, like a hyper-realistic hologram – and your own head-movements are tracked so that, unlike 360 video, you can move around the image and see it from different angles (that's the AR part).

We've seen Zubr's set-up in action and it's mightily impressive. Viewing their recreation of a Banksy painting here in Bristol, we didn't just get a sense of being there – we could actually peer behind the dustbins that sit below the mural.

The potential here is huge. Imagine a power station. In the past, Focus would have shown you pictures of it in the magazine; now we can also bring you video on our website or mobile editions. Using a system like Zubr's, we could let you don a pair of goggles, focus on a small icon on the page and have a wander around the control room... all while sitting on the morning train. But it's not just about what we can do – it's about what you can do, too...



Project Syria looks at the aftermath of a bomb explosion. The audio and witnesses (above) describing the events are real, while the visuals (below) are a CG rendering of people scurrying around in complete confusion

VR CITIZEN IOURNALISM

The smartphone has seen a rise in 'citizen journalism', with Joe and Jane Public capturing pictures and video of world events and posting them to blogs, YouTube and so on. Today, apps that let you capture your environment in 3D are growing in popularity, too. And there are two further emerging technologies that could make the whole business even more dynamic.

Photogrammetry and videogrammetry refer to the process of taking accurate measurements of an object or place from 2D photographs or video. While this process isn't new – archaeologists have used photogrammetry to create models of ancient sites for years – we now have the ability to turn those measurements into lifelike, animated 3D

Q&A The crusader

We talk to one of the pioneers in the growing field of 'immersive journalism', Nonny De La Pena...

models. You need a lot of raw 2D matter to work with, but if enough eyewitnesses captured pictures and video of, say, a riot on their phones, you could create a pretty realistic 3D representation of that event within a few hours for very little cost.

So 'citizen VR journalism', it seems, is just around the corner. You might not need to send a New York Times film crew to refugee camps, because the refugees themselves will be able to tell their stories to the world virtually. When we spoke, both Nonny De La Penna and Zubr director Jack Norris were very excited about the democratisation of VR via photogrammetry and videogrammetry, and it's easy to see why. VR technologies are already enabling important stories to be told in more engaging ways; with photogrammetry and videogrammetry, anyone with a smartphone can become the storyteller.

ETHICAL DEBATE

All of this, though, raises questions about ethics. Those working in TV, radio and print news (at least, those doing it right) have long adhered to certain standards regarding issues such as the use of traumatic imagery, and ensuring different views are represented in a story. And in these areas, VR journalism throws up a host of new dilemmas.

With regard to impartiality, for instance, if the viewer is shown one side of a story via the empathyinducing medium of VR, do they need to be shown the other side, too? If scenes are to be recreated in CGI, exactly now much 'recreation' is permissible – and how do you ensure that what's 'recreated' actually reflects reality? If you're shooting in 360 video - where there's no framing of shots, and a heap of dead, mangled bodies can't simply be filmed over or around - does the content-maker have a responsibility to spare the viewer scenes they might find distressing? And if you don't, do you risk desensitizing the viewer, and reducing one person's trauma to the status of another's entertainment?

The Displaced, for instance, attracted criticism for a scene shot from the perspective of a Ukrainian boy cycling down a war-ravaged street. Critics said this was interference, though Jake Silverstein, editor of The New York Times Magazine, argued such interference was minimal, "He had to wait to let us mount the VR rig on his bicycle, but once he did, he was riding his own bike down the street that he typically rides his bike down." Nevertheless, former Washington Post managing editor Robert Kaiser expressed concerns about a future where VR stories "will often be based on tricks and deceptions by photographers [and] cameramen".

To that end, Nonny De La Pena is already working with one leading US broadcaster to draw up a set of ethical guidelines for VR (see Q&A box), while the European Journalism Observatory's ongoing 'build your own ethics code' project - an attempt to create a crowd-sourced, widely-agreed set of standards for online and digital journalism – is now embracing

Your films combine different media - the real and virtual. Can you explain how that works and why you use that approach?

We utilise gaming platforms to create content but, as a very minimum, I use audio from the real world. Then I want to put you in the scene, and I do that using computer-generated imagery. But it's based very carefully on photographs, video and audio from the actual scene, so it's grounded in the same practice that I would have used to make my documentary films.

Is that something you'd always stick to or would you have used real footage of the Aleppo explosion seen in Project Syria, for instance, if you'd had it?

Well, 360 video can be very powerful, and we do use it for certain stuff but it's still 2D imagery. You can't move around, and there's something unique about being able to move around that is much closer to how we experience the real world. So a hybrid solution works best for now, but soon I'm going to start working with videogrammetry, where you can capture the physical, real world in such a way that it still allows you to walk around. The field is changing very quickly.

What are the implications for ethics and believability? How do we know that a VR film, as opposed to standard film footage, is telling us the truth?

My company Emblematic Group is working with the documentary series Frontline to produce a set of guidelines for best practices, but those won't be published for another year. In the meantime, I have to be as transparent as possible. I show people how we document every square inch of a space before we produce it. I've had people who are from Aleppo, who know the area where the bomb goes off in my film Project Syria, come out bawling, saying, "You've even recreated the exact colour of the bricks," which are a type you only find in Aleppo. So really it's about trusting the news organisation involved. But that's always been the case with print and TV, too.

Will VR replace those media?

No. Remember how everyone predicted the end of the book and yet print has never gone away? This is just another new form. There are audiences who are extremely comfortable with digital environments, and this is a no-brainer of a space for them to get their news. But that doesn't mean that text is going away!

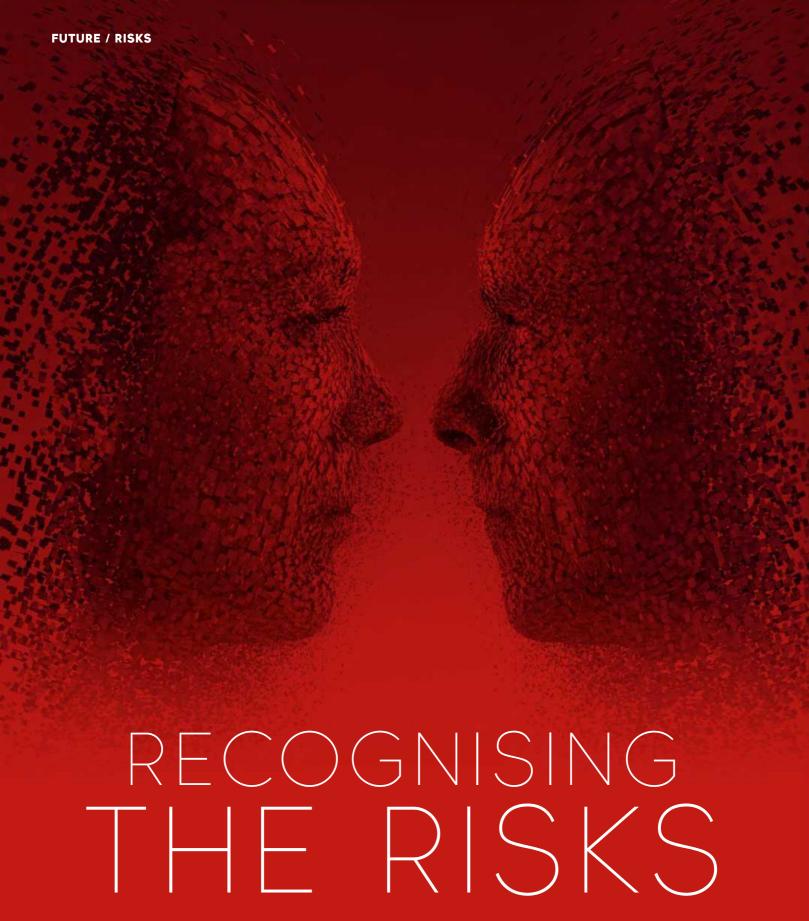


Bristol-based Zubr are pioneering a blend of virtual-reality and augmented-reality techniques that make embedded 3D images leap out from a 2D format like a hyper-realistic hologram. This could have connotations with how the media create and present news stories questions regarding the use of VR technology, too.

During the Crimean War in the 1850s, WH Russell of *The Times* was the first war correspondent to travel to the frontline with the troops; his harrowing, accounts of what he saw inspired Florence Nightingale to set up her military hospitals. In the late 1960s, the Vietnam War was the first whose atrocities were beamed into people's

homes via television, resulting in a huge protest movement that eventually stopped the war. In the 2010s, with VR journalism in its infancy, it remains to be seen what its impact will be. But given the medium's more engaging nature, that impact is unlikely to be anything less than significant. (2)

Russell Deeks has been writing about consumer technology since Walkmans and VHS players were the hottest hardware in town.



VR signals a brave new world of immersion. But, like any game-changing medium, some factors remain unknown...

Words: David Boddington



ou can't open up a tech magazine without seeing that 2016 has been dubbed 'the year of VR', and with good reason. While 2015 saw Google Cardboard and Samsung Gear virtualreality headsets enter the

market, it's this year that the big boys like Oculus Rift will finally hit the shelves.

Surely, then, the magical virtual future we were promised in the 1990s [see history of VR, page 8] is finally here? Perhaps. But although the latest technological developments are indeed providing the deepest and most impressive immersion in virtual worlds to date, the potential dangers inherent in VR are yet to be fully understood.

OVERCOMING CYBERSICKNESS

Virtual-reality sickness (also known as cybersickness) is a side-effect experienced by some when using VR. Symptoms are similar to those of motion sickness, including nausea, disorientation, pallor, headaches, sweating and even vomiting. It's widely thought that this is caused by a conflict taking place within the brain.

Your visual and auditory sensory inputs tell you that you're moving through space, whereas your inner ear doesn't detect the corresponding motion. Similarly to motion sickness, the 'area postrema' in the brain senses this conflict, assumes you're hallucinating after accidentally







ingesting a neurotoxin and tells your body to eject the offending substance post-haste. (There's more on this phenomenon in the Q&A section, beginning on page 83.) This phenomenon is more likely to affect children between two and 12 years, which is why some VR unit manufacturers advise caution or even for their units to be used only by children of 13 and over.

Thankfully, many of these short-term side effects have been reduced by technological

developments over the last few years and will continue to do so as time rolls by. Increased resolution and screen refresh rates have had a positive impact, as has game design itself, with developers gaining a deeper understanding of what makes a truly immersive and stable VR experience.

Increased resolution and screen refresh rates have had a positive impact on cybersickness

RAT REALITY

Research is, however, being carried out to uncover whether the impact VR has on the brain is more significant than the superficial symptoms of cybersickness. Professor Mayank Mehta and his colleagues at UCLA (University of California, Los Angeles) have been conducting experiments to explore the effects of VR on the brains of rats.

By building an environment in which the animals can explore a virtual space on treadmills, the team have been able to monitor activity in the hippocampus – an area of the brain important for spatial awareness, learning and memory. They found that around half the neurons that fire in a real-world environment simply shut down when in VR. Research is ongoing to

LEFT: Despite technological improvements, cybersickness is still experienced by some when viewing virtual reality

VR SAFETY

BEATING THE PHYSICAL ISSUES

Five common VR hurdles that are being overcome by developers...

1 Field of View In order for VR

In order for VR to feel immersive, a field of view (FoV) of around 60° has to be maintained. The human eye can perceive a FoV of 200° so the greater the FoV in VR, the more immersive and 'real' the experience feels. The StarVR headset has the highest FoV on the market at 210°.

2 Comfort and immersion

Decreasing the size and weight of virtual-reality headsets is also of great importance long term. The Samsung Gear VR, for example, weighs in at over half a kilo, whereas the Oculus Rift consumer release will be less than 380g. Long-lasting comfort will only really be achieved when units weigh under 150g.

1 Movement

Many gamers want to play first-person shooters in VR, but everything has to slow right down in order to avoid cybersickness. Walking speed needs to be reduced from the approximately 7m/s of Call of Duty, to less than 1.5m/s, while strafing (to attack repeatedly with guns or bombs) needs to be done at a snail's pace of less than 1m/s.

4 Hand tracking

Being able to pop on a headset and then use your hands to interact with the virtual world is the next great challenge facing VR. Wireless controllers and gloves can work well, but newer products like Leap Motion are a glimpse into the future, attaching to the front of a VR headset and employing cameras to track your hands directly.

Translucency

You can combat cybersickness by decreasing the opacity of the viewing surface, effectively enabling the user to spatially anchor themselves in the real world. Headsets that can do this on-the-fly will also allow for augmented reality applications to be run.

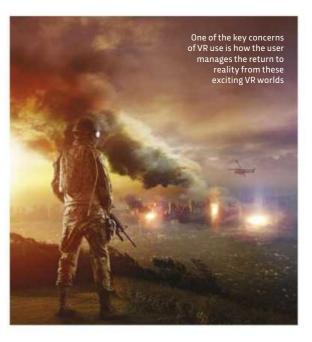












what impact this may have on the brain, but it at least intimates that the industry and researchers are taking the issue of VR and physical and mental healthy seriously.

SOCIAL IMMOBILITY

Truly understanding the long-term neurological impact of VR in humans will take time, but what of the social ramifications? We've already seen the dangers that immersive gaming can pose in the MMO world, with isolation and reclusive behaviour, depression, suicide and even virtual-world conflicts spilling over into real-world violence.

There was even the 2008 case of a Russian man dying after becoming embroiled in conflict resulting from the (virtual) death of one of the members of his game. A physical violent brawl ensued and the man died. Although such extremes tend to be rare, they do happen, and the introduction of VR into mainstream culture means that unexpected social problems will inevitably come to light.

Having spent a lot of time in VR ourselves, one of the most peculiar sensations isn't being in the virtual world itself, but the act of removing the headset at the end of the session, which is followed by the dull thud as you return to a comparatively beige reality, devoid of the wonder and boundlessness of the synthetic. It's all too easy to see how, as the technology advances with ever greater velocity, users young and old will become ever-more reluctant to return to reality. Imagine trying to get a teenager to do their homework when they're busy in the cockpit of an X-Wing, taking down the Death Star single-handedly. You'll need more than Jedi mind tricks for that one.

This escapism isn't just limited to gaming. As with so many technological developments, much will be driven by the porn and sex industry. Teledildonic Virtual reality and social media opens up a whole new frontier of sexual exploration sex (remote sexual activity) is already bedding in, as products that allow partners many miles apart to control mechanical sex toys in real time are flying off the shelves. Combined with VR and social media, this opens up a whole new frontier of sexual exploration. That's fair game for liberal, single individuals but what ethical rules apply if you have a partner and are having a virtual sexual encounter with a digital avatar? Perhaps it will simply be up to each and every individual, but it'll only be a matter of time before such

cases are raised in court.

INTO THE UNKNOWN

As is so often the case with new technology, there are many unknowns. Further studies into how VR impacts brain function are required to understand the potential pros and cons, while discourse on the social implications of the technology is equally important. Like most things in life there are potential risks but, used wisely, virtual reality will bring positive experiences to millions.

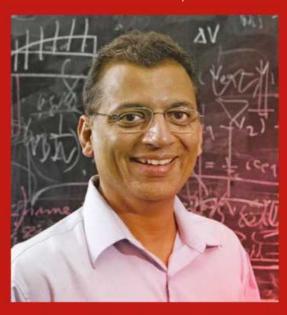
Even now, organisations like the charity Special Effect, who develop and supply video-game control systems for people with disabilities, are taking advantage of the latest technology. As founder Dr Mick Donegan suggests, these systems "could allow people with severe mobility challenges, even those who are completely paralysed, the opportunity to 'move freely' in both the real and virtual worlds". And it's through applications like this that VR will truly unlock its full potential, regardless of the possible downsides.

BELOW: Clinicians continue to research the potential side-effects of time spent in VR



ABQ

Professor Mayank R Mehta of the Department of Physics and Neurobiology at UCLA on the unknowns of VR...



Which parts of the brain see a decrease in activity when in VR?

All our experimental measurements were undertaken in a brain region called the 'hippocampus', which is very important for things like learning, memory and spatial navigation. It's also a region that's associated with epilepsy, Alzheimer's disease, ADHD, PTSD and depression.

How does the hippocampus work in real space?

That's a long story. Essentially, when a subject, which can be rats or humans, walks around in an environment, different neurons in the hippocampus become more activated in different parts of the maze and provide a cognitive map of the environment. In addition, the hippocampus activity also becomes more rhythmic. We found that both of these things were significantly altered in VR. The spatial maps were sort of lost in VR and the neural rhythm was also altered.

Why are VR units generally not recommended for use by young children?

Partly due to the reasons above. Other reasons also exist. For example, children's brains are far more plastic and changeable than adults and hence it's possible that some problems VR creates for the brain could have a bigger, more lasting effect on children's brains than adults.

Could long-term damage to the hippocampus, or other areas of the brain, result from VR usage? We don't know but we can't rule this out. We want to do experiments to test this fully.



We've seen the gaming, entertainment and commercial potential of virtual reality, but what will the social ramifications for the burgeoning new platform be?

WORDS: DOM RESEIGH-LINCOLN

Going public with cafes

Once upon a time, when the internet became more than a backroom experiment for software engineers, the internet cafe was all the rage. It provided the perfect platform to delve into the exciting world of the web. Cost effective and approachable, it brought together people of all walks of life to surf and send emails at the dawn of a new commercial age of technology.

Virtual reality, with its sciencefiction roots and reborn form, feels a similarly alien prospect, so it's intriguing and a little comforting to know that the technology 'cafe' is set to experience something of a renaissance. HTC, the Taiwanese smartphone manufacturer behind VR headset Vive, believes that virtual reality offers a new avenue for social interaction – so much so that HTC has signed a sizeable deal





with a Chinese internet cafe chain to bring its headset to 100,000 of its outlets.

In China, the internet cafe is very much still alive - there are over 200,000 of them – and HTC hopes that having such a significant customer base will enable users to With the Vive, HTC is hoping to tap into China's huge internet cafe customer base to promote the headset on a huge scale

share their experiences with others through solo and group apps. Such sites might take a little longer to seed in the West, but the idea of enjoying VR in a safe, pre-set-up environment might make the experience far more attractive to curious new users.

world, and enjoying the

experience on a night out in

entertainment vou'd

"Taiwanese smartphone manufacturer HTC has signed a sizeable deal with a Chinese internet cafe chain to bring its headset to 100,000 of its outlets"

Social media meets multimedia

both existing ones re-appropriated for VR and those built specifically for it, will play a pivotal role in the future of virtual reality as a social platform



AltspaceVR combines the principles of a social media platform with the concept of a multimedia centre. Imagine meeting up with your friends,

wherever they might be in the

Soon. there'll be no excuse for missina university lectures

person. Or coming together to visit a comedy club for a good laugh. More than that. it feeds directly into other social spheres. For

instance, users can attend lectures together and keep up with their

chosen subject, even if they're not able to attend the course in person. Or you could use Altspace to play Dungeons & Dragons, a game built designed to be played face-to-face.

Social spaces like these will break down walls, not iust for able-bodied users. but also for those that are house-bound or debilitated by disability. Suddenly the world isn't a place outside a set of walls - it's a social environment ready to be explored from home.

ALTSPACEVR ILLUSTRATION: ANDY POTTS PHOTO:



4

EVE:Valkyrie is just one of a number of VR games looking to use multiplayer to expand the social side of VR

Making gaming sociable again

Virtual reality will lend itself to plenty of single-player content in the coming months and years – and looking at the likes of demos such as *London Heist*, which did the rounds with PlayStation VR last year, those games will be all about immersing the solo player – but it's in multiplayer where things are going to get really exciting.

CCP, the acclaimed Icelandic developer behind the tactical sci-fi MMO EVE:Online, is putting the finishing touches to EVE:Valkyrie, a space-based dogfighting simulator that will project you, and multiple other users, into one giant space battle. From your fully automated virtual cockpit you can communicate with other players and form squadrons, working together to take on others in PvP (player vs player) or PvE (player vs environment) against the game's in-built AI.

Sony, with its PlayStation VR headset running off the PlayStation 4, is looking to use the concept of 'asymmetrical gaming' (one player vs a group of



"Icelandic developer CCP is putting the finishing touches to EVE:Valkyrie, a space-based dogfighting simulator"

players) to power many of its future multiplayer projects. "This will make it a more social experience so there'll be greater interest in trying VR as you won't feel as awkward [with VR head units on] with other people around," comments Shuhei Yoshida, head of Sony Computer Entertainment Worldwide.



Existing in virtual space is all about representing yourself, so apps such as vTime will offer a huge breadth of customisation

"Customise your avatar and enter rooms themed with 360° images. These rooms act as conversation platforms"

The social network reborn

Facebook and Twitter have revolutionised how we communicate with the wider world, and how we share and document our lives. And with Facebook's

investment in Oculus Rift and the future of VR as a whole, it's clear social media will play a pivotal role in its success as a social platform.

For Clemens Wangerin, the managing director of VR social network vTime, the social possibilities are endless: "If you're into VR, vTime will give you a way to connect to other users across the world. For us, it's that sense of 'social presence' – of actively feeling like you're in a different place and you're sharing that with another person."

For vTime users, that means slipping on a headset – the programme is being tailored for everything from Cardboard to PlayStation VR – and instantly entering a virtual lobby. From here you can customise your 3D avatar and enter rooms themed with 360° images. These rooms act as conversation platforms for up to four different users, and you can shift

between rooms like you would threads on a social media feed.

Much like its potential in education, VR creates a potential equality for users who might be otherwise hindered by barriers in real-life. "Users that lack confidence might find it easier to communicate and be themselves in a space such as vTime," says Wangerin. "VR offers you the chance to break out of that bubble and feel like you're doing more than just chatting to someone on the phone or over a Facetime video. It's the idea that you're somewhere else – with someone else – and that's really exciting to us."

VR's potential is huge and if, as predicted, it finds success in the mainstream, a whole new world of social interaction awaits. The world, already shrinking, will now seem even smaller as we meet new people in incredible new places, forming bonds and sharing the media that documents and defines our lives.

Dom Reseigh-Lincoln is a Bath-based freelance journalist specialising in virtual reality, technology and video games.









THE COMPLETE GUIDE

"OH MAN, THIS IS GONNA BE HUGE. ORDINARY PEOPLE ARE INTERESTED IN VR, NOT JUST US CRAZY SCI-FI NERDS"

PALMER LUCKEY, OCULUS RIFT FOUNDER

